WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

UMASS/AMHERST
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WEST BRANCH of the WESTFIELD RIVER WATERSHED

BERKSHIRE, HAMPDEN & HAMPSHIRE COUNTIES
MASSACHUSETTS

August, 1969

ADDENDUM

to

Watershed Work Plan

for

Watershed Protection and Flood Prevention

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED

Berkshire, Hampden and Hampshire Counties, Massachusetts

Pursuant to Notice of Change in Discount Rate, Water Resources Council, dated July 14, 1969, the interest rate to be used by Federal Agencies in the formulation and evaluation of plans for water and related land resources is increased from 4 5/8 percent to 4 7/8 percent for the period July 1, 1969 through and including June 30, 1970.

The effect of this increased interest rate on the Watershed Work Plan for Watershed Protection and Flood Prevention, West Branch of the Westfield River Watershed, dated July, 1969 is:

Average Annual Benefits - $635,291
Average Annual Costs - $376,522

Revised Benefit Cost Ratio - 1.7:1

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED

WATERSHED WORK PLAN AGREEMENT

between the

Berkshire Conservation District
Local Organization

Hampshire Conservation District
Local Organization

Hampden Conservation District
Local Organization

Massachusetts Department of Natural Resources
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

Commonwealth of Massachusetts

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

July 1969

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the West Branch of the Westfield River Watershed, Commonwealth of Massachusetts, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the West Branch of the Westfield River Watershed, Commonwealth of Massachusetts, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about seven years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated Cost - $1,478,150).

   The Sponsoring Local Organization agrees that all land acquired or improved with P.L. 566 financial or credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of works of improvement.

3. The percentages of construction costs of structural measures to be provided by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Constr.Cost (dollars)
Multipurpose Structures:			
Factory Site			
Reservoir	39.0	61.0	705,700
Recreation Facilities	50.0	50.0	776,160
Cherry Site			
Reservoir	21.3	78.7	220,500
Sanitary Facilities	100.0	0.	7,000
Coles	12.9	87.1	174,000
Cushman Site	10.5	89.5	96,200
Rudd Site	23.6	76.4	122,000
Shaker Site	20.2	79.8	202,800
Upper Coles Site	31.8	68.2	176,700
Upper Factory Site			
Reservoir	26.0	74.0	316,300
Sanitary Facilities	100.0	0.	7,000
Walker Site			
Reservoir	8.5	91.5	211,600
Sanitary Facilities	100.0	0.	7,000
Single Purpose Structures:			
Floodwater Retarding Strs.			
Blandford Site	0	100.0	79,300
Brooker Site	0	100.0	303,500
Channel Improvements	0	100.0	145,450

4. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engr.Cost (dollars)
Factory Recreation Facilities			
A & E contract for geologic investigations	50.0	50.0	50,000
A & E contract for surveys and designs	100.0	0	125,000
Sanitary Facilities (Walker, Upper Factory, Cherry Sites)	100.0	0	3,150
All Other Structural Measures	0	100	349,700

5. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $9,000 and $596,700 respectively.

6. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

7. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm plans on their land.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1 - 15.12), which provides that no person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

BERKSHIRE CONSERVATION DISTRICT
Local Organization

By _____

Title Chairman

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Berkshire Conservation District adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date _____

****

HAMPDEN CONSERVATION DISTRICT
Local Organization

By _____

Title Chairman

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Hampden Conservation District adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date _____

HAMPSHIRE CONSERVATION DISTRICT

By S/Richard L. Johnson

Title Chairman

Date August 26, 1969

The signing of this agreement was authorized by a resolution of the governing body of the Hampshire Conservation District adopted at a meeting held on August 26, 1969.

S/Allen M. Fisher
(Secretary, Local Organization)

Date August 26, 1969

****

MASSACHUSETTS DEPARTMENT OF NATURAL RESOURCES
(Local Organization)

By S/Arthur W. Brownell

Title Commissioner

Date September 5, 1969

****

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

By S/Kenneth E. Grant

Date Feb. 12, 1970

WATERSHED WORK PLAN

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED

Berkshire, Hampden and Hampshire Counties,
Massachusetts

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Prepared by: Berkshire Conservation District

Hampden Conservation District

Hampshire Conservation District

Massachusetts Department of Natural Resources

with assistance by:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

U. S. Fish and Wildlife Service

Massachusetts Division of Fisheries and Game

Massachusetts Water Resources Commission

July 1969

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WATERSHED WORK PLAN

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED

Berkshire, Hampden and Hampshire Counties, Massachusetts

July 1969

SUMMARY OF PLAN

Location and Sponsors

The West Branch of the Westfield River Watershed is located in the Berkshire Hills in Western Massachusetts. The watershed area, about 60,800 acres, lies in Berkshire, Hampden and Hampshire Counties.

The Sponsors of this project are: Berkshire Conservation District, Hampden Conservation District, Hampshire Conservation District and the Massachusetts Department of Natural Resources. Application was made for assistance on May 15, 1960.

Watershed Problems

Flooding is the main problem in the watershed. The areas affected are the developed areas along the West Branch of the Westfield River and its tributaries. The problem areas receive the runoff waters from the surrounding Berkshire Hills. These waters, concentrated along the river flood plain, are unable to enter the Westfield River before flooding occurs.

Because of seasonal fluctuations, the natural stream flows of the West Branch of the Westfield River and its tributaries do not provide sufficient flows of quality water in amounts to meet the needs for trout habitat during the summer months. There are no lakes with access within the watershed with water suitable for trout habitat. The waterfowl population is limited by the scarcity of water, food and cover. There are also very limited public use opportunities for waterbased recreation within the watershed.

Project Objectives

The objectives of this work plan are to protect the developed areas along the river from flooding; to provide fish and wildlife resource improvements and water oriented recreational opportunities; and to stabilize and increase summer low-flows in the streams.

Measures to be Installed

These objectives will be attained by the installation of land treatment and structural measures. The estimated installation cost is $6,287,365, of which $3,563,345 or 57 percent will be from P.L. 566 funds and other funds will provide $2,724,020 or 43 percent. In addition to project needs, the Department of Natural Resources has or will acquire about 1,850 acres of land adjacent to the structure sites to meet future needs for open space and recreation.

Land treatment measures have been selected which will preserve and improve hydrologic conditions within the watershed. The renovation of grasslands will provide increases in forage and stabilize the soil. Forest improvement work will reduce sediment and storm runoff. The recreation measures will provide increased opportunities for recreation on private lands within the watershed. Wildlife measures, applied by private landowners, will increase the production of wildlife.

The installation cost of land treatment measures is estimated to be $124,455, of which $30,053 will be from P.L. 566 funds for accelerated technical assistance. Additional technical assistance in the amount of $15,222 will be borne by other funds.

Structural measures, consisting of nine multipurpose structures, two single purpose floodwater retarding structures and 0.66 miles of channel improvement, are designed to supplement the land treatment measures and to alleviate the dominant watershed problems. A Recreational Development will be provided at one of the multipurpose structures. The eight remaining multipurpose structures will provide permanent pools for fish and wildlife and/or contain capacity for low flow augmentation to benefit fisheries in the streams. Lands acquired along approximately seven miles of streams will provide public access needed to realize benefits from low flow augmentation.

The estimated installation cost for structural measures is $6,162,910 of which $3,533,292 will be from P.L. 566 funds and $2,629,618 from other funds.

The total estimated installation cost of both the land treatment and structural measures, to be completed within the seven year installation period, is $6,287,365.

Project Benefits and Cost

Annual benefits from structural measures used for project justification are $635,291, with annual costs of $361,669. The overall benefit-cost ratio for the project is 1.8 to 1.0. Included in the benefits above are flood prevention benefits of $87,458, secondary benefits of $56,429, recreation benefits of $369,000, fish and wildlife benefits of $122,404.

The proposed project will provide an estimated 95 percent reduction in average annual floodwater damages.

Project Installation and Financing

The Berkshire, Hampden and Hampshire Conservation Districts will execute agreements with landowners for the installation of the land treatment measures. The Massachusetts Department of Natural Resources will be responsible for acquiring the necessary land and water rights. The Massachusetts Water Resources Commission, acting through the Division of Water Resources, will be responsible for contracting for the construction of the structural measures in the plan. Funds for the payment of the non-Federal share of the installation costs of the structural measures will be provided under Chapter 634, Acts of 1968 enacted by the Massachusetts General Court on June 16, 1968.

Operation and Maintenance

Operation and maintenance of land treatment measures will be the responsibility of the individual owners of properties on which measures are installed.

Annual operation and maintenance costs for all structural measures are estimated to be $73,492. Specific responsibilities for operation and maintenance are outlined in this plan under "Provisions for Operation and Maintenance."

DESCRIPTION OF THE WATERSHED

Physical Data

The West Branch of the Westfield River Watershed is located in the beautiful Berkshire Hils in western Massachusetts. The watershed area contains about 60,800 acres; with 32,000 acres in Berkshire County, 18,300 acres in Hampden County and 10,500 acres in Hampshire County.

Portions of eight towns comprise the watershed area, with a year-round population of about 1700 residents. The watershed is rural in character and sparsely populated. However, highly populated centers are nearby and summer residents and tourists are numerous. Such large cities as Boston, Worcester, and Springfield, Mass., Hartford, Conn., Albany, N.Y. and New York City are within several hours or less driving time of the watershed. The latest population estimate indicates that within a 50-mile radius of the watershed there are 1,500,000 people; within a 100-mile radius, 10,000,000; and within a 150-mile radius, 25,000,000 people.

Originating at the confluence of Depot and Shaker Mill Brooks in Becket, the river flows southeasterly about 17 miles through the steep mountains and narrow valleys of the Berkshire Hills to its confluence with the Westfield River at Huntington Center. The river is a typical mountain stream with an average gradient of 38 feet per mile. The streambed is greatly incised and is a mixture of boulders, coarse gravel, rubble and bedrock. The flow varies greatly with the 31-year average (1935-1966) being 178 cubic feet per second at the U.S.G.S. Stream Gage just above Huntington, Mass. The maximum flow of 26,100 cfs occurred on August 19, 1955 and the minimum flow, 3.3 cfs, occurred on August 9, 1955.

The topography of the watershed is characterized by steep mountains with narrow valleys. Elevations vary from about 400 feet at Huntington Center to over 2100 feet at the ridges in the headwaters. The watershed area, developed on a gneiss bedrock surface, is generally covered with a mantle of glacial till, glacial kame terrace or glacial moraine deposits. In some of the wider valleys, terrace deposits formed flood plains which are subject to frequent inundation.

Soils in the watershed are primarily upland soils with small areas of sandy and gravelly terrace soils, sandy alluvium and muck. The dominant upland soils (Marlow and Peru) were formed in very compact glacial till and are extremely stony and bouldery with a loamy surface texture and underlain by compact soil material. Shallow to bedrock soils (Lyman and Westminster) are underlain by bedrock at depths of 18 inches or less. Bedrock outcrops and ledges are common.

Terrace soils (Hinckley and Merrimac), sandy alluvium soils (Ondawa, Podunk and Saco), and muck soils occur as small isolated areas along the drainage channels throughout the watershed.

Mean temperatures range from 22° in January to 68° in July. The average growing season is 119 days, from late May to mid September. Average annual precipitation, distributed throughout the year, is 44 inches with a runoff of 26 inches. The yearly snowfalls range from 45-60 inches and may occur in appreciable amounts from November to April.

Approximately 90.7 percent (or 55,134 acres) of the watershed is in forest cover. It has been determined that 25 percent of the forest land is in poor hydrologic condition, 25 percent in fair, 29 percent in good and 21 percent in very good hydrologic condition. With continued protection and more intensified management, most of the forest should be in good to excellent hydrologic condition at the end of the evaluation period.

The estimated land use for the remainder of the watershed is: cropland - 5.2 percent; pasture - 1.3 percent; urban - 0.2 percent; other - 1.9 percent and water - 0.7 percent. An examination showed that there were no apparent erosion or hydrologic conditions which would adversely affect the design, operation or maintenance of the reservoir structures.

Economic Data

The area is rural in character with about 1700 permanent residents. The majority of the active farms are operated by landowners who are generally employed outside of the watershed. The watershed population has shown a slight decline since 1900, although in recent years there has been an increase in the number of families who spend their summers in the Berkshire Hills. Also, the Berkshire Hills are attracting increasing numbers of tourists to enjoy the cool summer climate, the fall foliage and winter sports, such as skiing. There are two major manufacturing enterprises engaged in the mauufacture of abrasives in the watershed.

Within the watershed, there are about 40 active farms averaging 140 acres in size, many of which are dairy farms. About 25 percent of the farm owners are cooperators with their local Conservation District and have Basic Conservation Plans on their farms. Most of the crops grown are utilized on the farms. With the decline in farming in this watershed, cropland and pasture acreages have declined until only about 3,200 acres of cropland and 800 acres of pasture remain.

With the decline in small industries, farming, timber and timber by-products, railroad employment, and the resultant decline in population, the area is faced with a decreasing economic base. Indications are that the economic future of this area is in the development of recreational enterprises to attract summer residents and tourists. During the last decade, the creation of new lakes and the development of existing lakes by private interests has raised land values and broadened the tax base of some towns within the watershed. For example, a lake development in the Town of Becket, begun about six years ago, accounted for nearly 60 percent of the Town's total real estate assessment. This development not only relieves some of the tax burden on the permanent residents, but also contributes to the economic well being of merchants and other small businesses in the area.

That portion of the watershed in the towns of Becket, Washington and Peru, Berkshire County, is within the Berkshire-Franklin Resource Conservation and Development Project area. The overall objective of the project is to improve the social, physical, and economic environment of the region. The works of improvement proposed in this work plan will be complementary to this objective.

Except for about 6,000 acres owned by the Commonwealth of Massachusetts and administered by the Division of Forests and Parks and about 800 acres held by the Town of Chester in its municipal watershed, all of the forest land is in private ownership. An estimated 400 forest landowners have holdings in the watershed.

The present forest stands consist of 75 percent hardwoods (mainly the northern hardwood type with associated species and oak stands on south-facing slopes); 4 percent softwood (red spruce, white pine and hemlock); and 21 percent mixed stands of softwoods and mixed hardwoods. About 21 percent of the forest stand is saw timber size having more than 1,500 board feet per acre and 66 percent of the forest stands is seedlings and saplings

Local markets exist for quality sawlogs, boltwood and miscellaneous forest products. Markets are limited for both pulpwood and lower quality sawlogs.

Adequate forest fire protection is provided by the eight towns within the watershed and the Massachusetts Department of Natural Resources, Division of Forests and Parks, in cooperation with the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program. Other current Federal-State Forestry programs include Cooperative Forest Management,

Cooperative Forestation and Cooperative Insect and Disease Control. Given protection, care and management, the forest stands are expected to increase their contribution to the economy of the watershed.

A network of secondary roads and major highways provides access to all parts of the project area. U.S. Route 20 and State Route 8 pass through the watershed, while the Massachusetts Turnpike crosses the southern portion. Local town roads, connecting with major highways, provide easy access to all areas of the watershed. The Penn Central Railroad runs up the valley of the river from Huntington to Becket.

Fish and Wildlife Resource Data

There is a need for water surfaces with public access to fill outdoor recreation demands. According to the Division of Fisheries and Game's latest classification of great ponds with existing trout potential, there are no ponds in the watershed presently suitable for trout management. While there are four warmwater ponds within the watershed, they are largely controlled by private individuals; are without adequate public access; and contribute little to public fishing in the watershed. Yokum Pond, in Becket, is the only managed pond in the watershed. Undoubtedly, the numerous beaver flowages provide some recreational sport fishing, but these flowages represent only a small, temporary warmwater fisheries resource. The beaver flowages also discharge undesirable warmwater effluent into trout streams.

There are about 17 miles of the main stream and 94 miles of tributary streams in the watershed. The current demand for stream fishing is high and these demands will increase in the future. Augmentation of stream flows are expected to make a significant contribution toward meeting future needs for this type of fishing. At present, the main stream and about 32 miles of tributaries are managed for fishing by stocking with catchable trout. The major factors limiting trout habitat and recreational use are pollution; access; low summer flows; high summer termperatures resulting from wide stream beds, low flows and poor shading; and damaging spring flows. Even with the pollution abated, the remaining factors will tend to limit recreational fishing after the end of May. The overall limiting factor for streams is the low summer flows with the attendant high water temperatures.

The white-tailed deer is the major big game animal in the watershed. According to data compiled by the Division of Fisheries and Game, the watershed is an important deer hunting area. Current shifts in hunting pressure because of improved transportation, land closure in the eastern part of the state and increases in total hunters, suggest that the present hunting pressure is 18 hunters per square mile or 1,710 hunters.

The major upland game species include the ruffed grouse, woodcock, and varying hare. The cottontail rabbit, squirrel and pheasant are also present in lesser numbers. Important furbearers include beaver, muskrat, mink and otter, which are heavily trapped and represent an important natural resource.

The watershed does not currently provide important habitat or hunting opportunities for waterfowl. Existing waterfowl habitat is coincidental and depends largely on beaver activity. Most beaver flowages support one or more broods of black and wood ducks. Because of the scarcity of standing water, the beaver flowages represent important feeding and resting areas for migrating waterfowl.

Recreation Data

At present, there are limited state water-based recreation areas within the watershed. Several small ponds have local or town beach areas. There are several boys' and girls' summer camps with private lakes scattered throughout the watershed. Opportunities are severely limited for a large segment of the population to participate in camping, boating, swimming, picnicking and fishing. The high potential for this watershed as a recreational area is due to the scenic beauty, favorable climate, year-round outdoor recreational opportunities and a large nearby population.

WATERSHED PROBLEMS

The dominant problems are damages from floodwater to developed areas along the river and its tributaries; inadequate opportunities for good fishing and recreation activities; and the seasonal pattern of streamflow, which provides an unfavorable habitat for fish in the streams.

Floodwater Problems

Major floods which occur in this watershed have the most damaging effect on the residential and commercial areas located along the West Branch of the Westfield River and its tributaries. There are 93 residences, 27 commercial establishments, 2 industries, 5 highway and 3 railroad bridges, 7 miles of highway and 1.25 miles of railroad and 5 utilities subject to flood damages within the watershed.

The watershed has experienced damaging floods in 1878, 1927, 1936, 1938, 1944 and 1955. Minor flooding occurs on the average of every five years. The occurrence of a 100-year frequency flood event would cause damages in excess of $1,900,000.

The major damage areas are the more developed areas along the river in Reaches 1, 2, 4, 5 and 11. Flood damages resulting from a 100-year frequency flood in these reaches would be $1,500,000. Other damages occur to scattered developments, roads, railroads and bridges in the other reaches.

Flood damage to highways and double track main line of the Boston and Albany Division of the Penn Central Railroad has caused closing of industrial plants, isolation of areas, re-routing of highway and railroad traffic and endangered the lives and safety of the residents of the watershed. Damages include losses of production and wages, and costs of rerouting traffic.

Sediment Problems

The high velocity floodwaters associated with large floods in the main stream and tributaries carry sediment downstream, depositing this sediment generally at bridges and deeper areas of the streams. This deposition reduces the depth of the small pool areas, thereby limiting the potential natural fish habitat and fishing value of the streams. However, sediment damages to properties and roads were not considered significant enough to be evaluated separately from floodwater damage.

Erosion Problems

Erosion damage consists primarily of erosion on upland areas and is not severe in this watershed. The major portion of the sediment transported by streams is derived from streambank erosion that occurs mainly during periods of high streamflows.

Fish and Wildlife Problems

The scarcity of large bodies of water suitable for fish management and the low summer flows greatly limits the opportunity for fishing. The Division of Fisheries and Game presently does not manage any ponds within the watershed for trout fishing. Of the four warmwater ponds, only one is managed for warmwater fishing. The low summer flows and resulting highwater temperatures limit the fishing potential of the streams and the use by fishermen to a short early spring period.

Also, there are no areas within the watershed that are managed for waterfowl. Wood ducks, black ducks and migratory birds presently utilize existing beaver ponds for nesting and resting areas.

The fishing resources in the watershed are inadequate to meet current demands. Trout stocked by the Division of Fisheries and Game in the streams quickly disappear in the creels of early season fishermen or are lost due to diminishing summer flows and rising water temperatures. Trout ponds with public access and storage capacity to be used for augmenting the low summer flows are needed to meet the increasing fishing demands within the watershed.

Recreation Problems

The latest population estimate indicates that within a 50-mile radius of the watershed, there are 1,500,000 people; within a 100-mile radius, 10,000,000; and within a 150-mile radius, 25,000,000 people. Because of this large, nearby population, the natural scenic beauty, favorable climate and easy access from the population centers, the potential for use of this watershed as a recreational area continues to grow.

Fisheries and recreation improvements and developments are needed to provide a rounded recreation opportunity for users, to increase the frequency of their visits and to prolong their stay.

Pollution Problems

Studies by the Massachusetts Division of Water Pollution Control indicate that reaches of the West Branch of the Westfield River are presently in a "D"[1/] condition. The Division finds that, with the installation of adequate treatment facilities, the entire West Branch will attain its assigned "B"[1/] classification. Storage of water for low-flow augmentation for water quality control purposes was, therefore, not considered.

PROJECTS OF OTHER AGENCIES

In 1966, the Massachusetts Department of Natural Resources constructed the Buckley Dunton Reservoir on Yokum Brook. This site was once considered as a possible location for a floodwater retarding structure. However, later investigations showed that a site, at this location, would have little value for flood control. The Buckley Dunton reservoir, a warmwater fishery, is a part of the Commonwealth Park System and will help to meet the demands for warmwater fishing in the area.

1/ Classifications established by the Massachusetts Water Resources Commission, Division of Water Pollution Control.

The Westfield River above Huntington consists of three major tributaries, the East Branch (162 square mile drainage area); the Middle Branch (52.6 square mile drainage area); and the West Branch. The U.S. Army Corps of Engineers has constructed reservoirs on the East Branch and the Middle Branch to provide flood protection to downstream areas along the Westfield River, the city of Westfield and the Connecticut River. The Knightville structure on the East Branch is a single purpose flood control structure. Future municipal water supply for the City of Springfield was included in the Littleville Multipurpose Structure on the Middle Branch. At the time the Littleville Reservoir was completed, it was estimated that the water storage would be needed in 1980. Until that time, the water supply storage would be used for recreational purposes. In 1967, the City of Springfield found that this water supply storage would be needed immediately. Plans and necessary construction are underway for the City to begin withdrawing the water supply storage in 1969. Therefore, all recreational usage, except for fishing in designated areas of the reservoir, will be prohibited.

The Corps of Engineers located a potential site on the West Branch of the Westfield River just above Huntington to provide additional flood protection to the downstream areas below Huntington. This site was found to be economically unfeasible.

BASIS FOR PROJECT FORMULATION

Local Sponsors wish to coordinate and develop a comprehensive program of land treatment and structural measures that will protect the watershed, alleviate flood damage and make maximum practical use of available water and land resources. Local people have assisted in determining the extent and nature of the problems. Measures included in this plan were formulated after watershed problems and resources were studied intensively.

The primary objective is to provide the maximum level of flood protection within the limits of sound economic and engineering principles. Various alternates were considered without regard to the relative Federal and non-Federal shares of the cost. The proposed project measures will protect most of the developed areas of Chester and Huntington against a flood of such magnitude that it will only have a one percent chance of occurring in any given year. This degree of protection for the major damage areas is considered adequate and will meet project objectives.

Other flood plain areas will be subjected to occasional inundation. In order to prevent or minimize damages in these areas, the Sponsors will

recommend the adoption and enforcement of flood plain management. This could include flood plain zoning and flood proofing.

A summary of the major objectives of the sponsors are:

1. Provide flood protection from the 100-year frequency flood event to the developed areas along the West Branch of the Westfield River and its tributaries.
2. Protect the watershed lands from erosion, flood runoffs, and promote orderly development of natural resources for outdoor recreation and wildlife.
3. Utilize the recreational potential of the area to meet demands for waterbased outdoor recreation.
4. Develop the trout fisheries potential of the watershed by creating impoundments and augmenting low stream flows.
5. Increase wildlife habitat, particularly for waterfowl.

Land Treatment Measures

Studies were undertaken to establish the types and amounts of land treatment measures needed to control erosion and reduce flood runoffs. Estimates of present land use and practices already applied were made from records in the Berkshire, Hampden and Hampshire Conservation District Offices.

Land treatment needs and goals were established by the Berkshire, Hampden, and Hampshire District Supervisors. A realistic land treatment program is difficult to plan due to the current trend of changing land use and declining agriculture within the watershed.

The measures selected are feasible and will reduce erosion and sediment production, retard flood runoffs and contribute to the recreational use of watershed lands.

Structural Measures

The structural measures were selected from alternatives for both the desired physical effects and benefits. The selected measures include nine multipurpose structures, two single-purpose structures and stream channel improvements.

Floodwater Retarding Structures

To provide the required degree of flood protection to the damage areas downstream, a system of eleven structures was selected. Capacity to control the expected runoff from a 100-year frequency storm from the structure watershed was included in each structure. The rate of release of floodwater through each principal spillway was based upon the stream capacity below the structure and in the damage areas. The capacities and release rates selected were determined to be the most feasible.

Fourteen other structures were also considered, but the eleven sites selected were found to be the most feasible, both economically and physically, and will best meet the sponsors' objectives.

Stream Channel Improvements

To provide protection from a 100-year frequency flood, it was necessary to include two sections of stream channel improvement for local protection to two areas along the river. Alternates considered were additional sites upstream of the two areas and diking to supplement channel work through the areas. The stream channel work was found to be the most feasible, both economically and physically, and would meet the objectives of the sponsors.

Recreation Improvement

Each of the eleven sites was evaluated to determine its potential for a recreation development for picnicking, swimming, camping and other water-based recreation. Consideration was given to site location, topography around the site, sizes and depths of various permanent pools, present land use around the reservoir, availability of undeveloped land and access to the reservoir. The Department of Natural Resources determined that the Factory Site would be the most desirable for a recreation development and would be compatible with the state's Master Recreation Plan.

The recreation facilities were selected to meet the anticipated need in the immediate future. Additional facilities will be provided as the need develops and funds are available.

Fish and Wildlife Resource Improvements

The eleven structure sites were evaluated individually to determine the optimum water resource use that could be included in the site. The location, topography and access were considered. The water resource improvements selected for inclusion in eight sites were the most

economical to provide the desired degree of fish and wildlife resources improvements. The need for sanitary facilities at each of the eight sites was carefully considered. An analysis was made of the anticipated annual use, average daily use, peak use, location in regard to urban and other areas and possible effects on water quality. This analysis showed that the anticipated use of the eight multipurpose fish and wildlife sites would be below the level where sanitary facilities are normally considered necessary. However, the anticipated use at the Cherry, Upper Factory and Walker Site Reservoirs is approaching the level where sanitary facilities are believed to be needed. To preclude the development of unsanitary conditions at these three site reservoirs, the Massachusetts Division of Fisheries and Game will install suitable sanitary facilities in the amount required.

The streams on which stream access will be provided were selected based on stream conditions, accessibility, and potential for increased fishing pressures.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Land treatment measures applied under the Berkshire, Hampden and Hampshire Conservation Districts' going Program will be within the capabilities of the land and in accordance with needs. Each District program will be accelerated to increase watershed protection. Table 1 shows the acreages, by major land use, which will be adequately treated during the project installation period. Conservation measures which are essential to protect and improve the land adequately will be applied.

The Massachusetts Department of Natural Resources administers over 6,000 acres of forest land in the watershed. The Department will install necessary land treatment measures to insure that its holdings are adequately treated to minimize erosion and retard runoff.

The Conservation Districts will provide consulting services to town boards and developers to advise on conservation measures needed on lands undergoing development. Conservation Districts will accelerate their Natural Resource Program to assist towns within the watershed in the orderly development of the towns' natural resources. The Natural Resource Program consists of an inventory of the areas and sites within a town which has natural resource potential and the preparation of a plan for the orderly

development of the town's natural resources for conservation and recreation. This plan is then included in the Town Master Plan, with a proposed schedule for implementation. It is expected that with accelerated technical assistance, at least two towns will prepare a Natural Resources Inventory and Plan during the project installation period.

Hayland and Pastureland

Practices which will improve the infiltration of water into the soil or maintain or improve the present vegetal cover are of the first importance. Practices may include pasture and hayland planting and pasture and hayland management. The pasture and hayland practices will achieve the desired result on the areas presently in grassland or expected to be converted to grassland.

Forestland

To insure proper land treatment and maximum watershed protection, the forest land treatment program provides for over 2,000 acres to be adequately treated during the project installation period. Tree planting; reforestation of open land; hydrologic cultural operations, including weedings, thinnings, improvement cutting, release work, and harvest cuttings; and skid trail and logging road erosion control are the planned program measures. These forestry practices will contribute to improved hydrologic conditions effective in reducing flood peaks, reductions in sedimentation, and in recharging ground water during the winter and spring. Individual management plans will be prepared for approximately 85 forest landowners, involving 6,800 acres. These plans are necessary for the proper installation and maintenance of approved measures. This service, together with other technical assistance to the landowners, insures that watershed values are not impaired.

Miscellaneous Land

Practices to be applied on private lands will be primarily to improve the land for recreational usage or for the preservation or development of wildlife by individual private landowners. The towns, in carrying out their Natural Resource Programs will install practices for conservation and recreation. Such practices may include recreation area improvement, recreation land grading and shaping, ponds, recreation trail and walkway, wildlife wetland management, and wildlife habitat management. These practices, or combinations of practices, will improve watershed lands for recreation and wildlife.

Technical Assistance

Technical assistance will be furnished to accelerate the land treatment program to meet project needs and to prepare Town Natural Resource Plans during the project period. This technical assistance is in addition to the technical assistance being furnished to the Districts and landowners from regular Soil Conservation Service funds and Cooperative Forest Management funds.

Structural Measures

Structural measures to be installed will supplement the land treatment program in alleviating the principal flood problems and in making more efficient use of available water resources. The structural measures consist of two single-purpose floodwater retarding structures, nine multipurpose structures and two sections of stream channel improvement. The nine multipurpose structures will provide a total of 658 acres of water surface, with 161 acres for recreational use and 497 acres for fish and wildlife use. Tables 1 and 2 show the estimated cost distribution. The Project Map (Fig. 14) shows the location for all structural measures. See Table 3 and Figures 1 through 13 for structure detail.

On the West Branch of the Westfield River above the confluence of Walker Brook in Chester, the seven structures will control 20.5 square miles or 38% of its drainage area. Three structures will control 10.5 square miles or 58% of the drainage area of Walker Brook at Chester. The eleven structures will control 33.4 square miles or 35% of the total drainage area of the West Branch of the Westfield River at Huntington.

Each of the eleven structures is designed to store the sediment volume expected to accumulate at each site over a 100-year period and will automatically regulate the runoff from a 100-year frequency storm. The dams will be constructed of compacted earth fill.

The typical principal spillway, to automatically retard floodwaters, will consist of a reinforced concrete riser and outlet conduit. The principal spillways in all the multipurpose sites except the Cushman Site will be designed to release the normal low water discharge and any low flow augmentation waters from the colder water near the bottom of the pools. A gate will be installed on the interior wall of the principal spillway riser to permit draining the beneficial pool and to regulate the release of any low flow augmentation water. Stoplogs will be incorporated in the Cushman Site principal spillway to allow for the manipulation of the wildlife pool water levels and to drain the beneficial pool.

Each site will have an emergency spillway excavated in earth or rock on one abutment of the dam. The emergency spillways will consist of an entrance channel, level control section and exit channel. These spillways will pass floodwaters in excess of the design capacity and will operate, on the average, not oftener than once in 100 years.

In the multipurpose structures, the beneficial pools will be cleared of trees and other vegetation. Additional clearing and grubbing will be done at each site, as necessary, to allow for the construction of the dam, emergency spillway and borrow areas. The upstream slope of the dam will be riprapped from the low beneficial pool elevation to approximately two feet above the highest beneficial pool elevation. The remainder of the dam and other disturbed earth areas will be protected by vegetation.

The Division of Fisheries and Game will install access roads and parking areas to the fish and wildlife resource improvement sites after the fishing pools have been stocked and are ready for fishing. The costs of these access roads and parking areas have not been recognized as a project cost. Adequate sanitary facilities will be installed at the Cherry, Upper Factory and Walker Multipurpose Fish and Wildlife Sites by the Division of Fisheries and Game. Sanitary facilities will be installed at the other multipurpose fish and wildlife site reservoirs as the need dictates in accordance with the surveillance program described under "Operation and Maintenance."

The Massachusetts Water Resources Commission will acquire all needed land rights for the installation of the structural measures. The Department of Natural Resources has selected and plans to acquire additional land areas to allow for the full future use and development of the structure sites. This land, although not an integral part of the project, is highly desirable for the future utilization of these sites to their maximum potential. The cost for this land is shown in Table 2 as non-project land rights costs. Public access will be provided at all sites.

Additional information pertinent to individual sites is listed below:

Factory Site Reservoir and Recreation Facilities

Reservoir

The Factory Site is located on Factory Brook about one mile west of Middlefield Center, Massachusetts, 0.2 miles north of Reservoir Road and 2 miles downstream from the Upper Factory Site Reservoir. This site is for multipurpose flood prevention and recreation development.

Of a total storage of 5,706 acre feet, 1257 acre feet will be for flood prevention, 4443 acre feet for recreation and 6 acre feet for sediment storage. The surface area of the recreation pool will be 161 acres, with a maximum depth of 50 feet. Principal features of the Factory Site Reservoir are shown on Figure 6.

The emergency spillway is planned to be in rock on the right abutment. The borrow area on the left side of the recreation pool will be excavated in a step-method, with each step graded for proper drainage. A small, gravelly knoll in the center of the dam will be removed. A cut-off trench will be excavated to bedrock and backfilled with impervious material.

Access to the reservoir will be provided as part of the recreation development. To provide access for stream fishing, adequate width will be purchased or otherwise acquired along each bank of Factory Brook from the Factory Development Boundary downstream to the West Branch of the Westfield River.

Recreation Facilities

The recreation facilities will be located on the east side of the reservoir pool as shown on Figure 12.

The recreation facilities will consist of: day use area; camping area; boat launching area; observation tower; and contact station. The day use area will have 200 picnic sites, each with table, fireplace and garbage receptacle. Hydrants will be conveniently located throughout the area for culinary water. A comfort station will be located to serve the picnic sites that are not immediately adjacent to the beach area. Parking for 200 cars will be provided in one central parking lot above the day use area. A large bathhouse, located beside the beach, will have flush toilets, hot showers and dressing rooms for swimmers. The beach will be graded and covered with clean sand. A roped-off swimming area and the necessary lifeguard equipment will be provided. Use of the picnic sites will be on a first-come, first-serve basis with no more than 200 cars allowed into the parking area at any one time.

The camping area will have 200 camp sites, each with table, fireplace and garbage receptacle. Each site will be graded and shaped to provide for either tent or trailer camping. Eight bathhouses, each with flush toilets, hot showers, and laundry rooms, will be located conveniently to each camp site. Electric lights and hydrants will be interspersed throughout the area. A beach area will be provided to serve the camping area. The shore line will be graded and covered with clean sand. A swimming area will be

enclosed with ropes and necessary lifeguard equipment provided. The use of the camp sites will be controlled with no more than 200 tents or trailers allowed at one time.

A sewage treatment and disposal system will be installed to service the day use and camping areas. Following the geologic investigations, the most economical and feasible system will be designed by a consultant engaged by the Department of Natural Resources.

A two-lane paved entrance road will run from the Skyline Trail to the contact station which will have a reception room and toilet facilities. Parking for 20 cars with trailers will be available nearby. From the contact station, two-lane paved roads will provide access throughout the camping and day use areas.

The observation tower will be located on the west side of the reservoir on one of the highest elevations in that part of the state. An entrance road, from the West Hill Road, will terminate in a parking lot. A comfort station will be provided adjacent to the tower.

The boat launching area is presently planned for the east side of the reservoir. During the final design of the recreation facilities, it may be found desirable to relocate the boat ramp to another location on the reservoir. The facilities provided will include a paved access road, parking area for 40 cars and boat trailers, comfort station with flush toilets and a boat launching ramp. This area will be separate from the day use and camping area.

The administrative building and maintenance and service areas will be located on Town Hill Road. An existing residence on land owned by the Department of Natural Resources will be converted for administering the park facilities and operating and maintaining the recreation development.

The reservoir and recreational facilities will be operated as part of the State Park System and will be available to the general public. Use of the day-use area and camping area will be controlled to prevent overcrowding of available facilities. User fees, consistent with regular fees charged for use of other State Parks, will be charged for use of the day-use and camping areas. No charges will be made for use of the boat launching area and observation tower.

Hiking and nature study trails will be developed throughout the State-owned area. These trails, laid out and constructed by the Department of Natural Resources, will be designed to traverse the rugged and mountainous topography of the area. These trails will be installed as the opportunity arises by the Division of Forests and Parks.

Blandford Site

The Blandford Site is located on a tributary of Walker Brook about 2 miles southwest of Chester, Massachusetts, on the west side of Blandford Road. This single-purpose floodwater retarding structure will have a total storage capacity of 247 acre feet, which includes 246 acre feet for floodwater storage and 1 acre foot is for sediment storage. Principal features are shown on Figure 1.

The reservoir dam will be protected by vegetation. An excavated earth emergency spillway is planned on the right abutment, with the existing drainageway diverted around the outer slope of the emergency spillway. The principal spillway will be ported at the streambed elevation to pass normal stream flows through the dam. An existing pond immediately below the dam will be protected during construction. The access road will be constructed around the exit channel of the emergency spillway from the Blandford Road.

Brooker Site

The Brooker single purpose floodwater retarding structure will be located on Shaker Mill Brook about 1.5 miles west of Becket, Massachusetts, between Lovers Lane Road and Brooker Hill Road at the Becket-Washington Town line. Of a total capacity of 650 acre feet, 643 acre feet will be for floodwater storage and 7 acre feet for sediment storage. Principal features are shown on Figure 2.

The reservoir dam will be protected by vegetation. The emergency spillway is planned to be in a rock and earth cut on the left abutment with a paved control section. The principal spillway will be ported at the streambed elevation to allow normal flows to pass through the dam. A compacted earth dike will be constructed in a low saddle upstream of the dam. The dam and emergency spillway are planned to cross the Lovers Lane Road, which will remain open if suitable alternate arrangements can be made. Access to the site will be provided from the Brooker Hill Road.

Cherry Site Reservoir

The Cherry Site is located on Cook Brook about 1.5 miles southeast of Old Chester Center and on the west side of the Chester Hill Road. This will be a multipurpose flood prevention and fish and wildlife structure. The site reservoir will have a total capacity of 1,110 acre feet, with 631 acre feet for flood storage, 472 acre feet for fish and wildlife and 7 acre feet for sediment storage. The surface area of the fishery pool will be 36 acres. The maximum depth will be 30 feet, with 34 percent of the area over 15 feet in depth. Principal features are shown on Figure 3.

The emergency spillway is planned to be in earth on the right abutment. Public Access to the site reservoir will be provided from the Chester Hill Road.

Coles Site Reservoir

The Coles Site is located on Coles Brook about two miles southwest of Middlefield, Massachusetts, and 1.5 miles below the Upper Coles Site Reservoir.

This multipurpose flood prevention and fish and wildlife structure will have 417 acre feet for flood prevention, 146 acre feet for fish and wildlife and 4 acre feet for sediment storage for a total capacity of 567 acre feet. The fishery pool will have a surface area of 12 acres, with a maximum water depth of 45 feet. About 51 percent of the surface area will be over 15 feet deep. Principal features are shown on Figure 4.

An emergency spillway excavated in earth is planned on the left abutment with an existing drainageway diverted around the upstream portion of the emergency spillway. Drain tile will be installed in the emergency spillway as necessary to intercept hillside seepage.

The partially abandoned Ryan Road, which crosses the upstream portion of the reservoir, will be closed to traffic. An underground A. T. & T. telephone cable crosses just below Ryan Road. The A. T. & T. Co. will be notified prior to construction and care shall be taken in all equipment operations in the vicinity of this cable. An overhead N. E. T. cable crosses just above Ryan Road. This cable will be raised to pass safely over the maximum flood pool. Ryan Road, from West Hill Road to a point near the site, will be improved to provide access to the fishery pool. Adequate widths of each bank of Coles Brook, from the dam downstream to the West Branch of the Westfield River, will be purchased or otherwise acquired to provide access for stream fishing.

Cushman Site Reservoir

The Cushman Site is located on Cushman Brook about 2.5 miles southwest of Chester, Massachusetts, and one mile south of the intersection of Route 20 and Quarry Road. Principal features are shown on Figure 5.

This multipurpose flood prevention and fish and wildlife structure will have a total storage of 462 acre feet, with 315 acre feet for flood prevention, 84 acre feet for fish and wildlife, 62 acre feet for design storage, and one acre foot for sediment storage. The wildlife pool will have a maximum surface area of 20 acres with a maximum depth of water of 16 feet. There will be 11 acres with a water depth from 0 to 3 feet.

The emergency spillway, located in a natural saddle near the right abutment, is planned to be in rock cut. Addition of 62 acre feet of design storage reduced the volume of rock excavation in the emergency spillway to achieve a more economical structure.

Flashboards will be incorporated in the principal spillway riser to regulate the wildlife pool water levels and allow for the gradual drawdown of the wildlife pool.

Construction of the dam will require the removal of large boulders that cover about 40 percent of the ground surface. These boulders will be placed on the downstream base of the dam or incorporated into the dam as a rock zone.

An access road will be provided from Quarry Road along an abandoned road to the wildlife pool.

Rudd Site Reservoir

The Rudd Site is located on Yokum Brook about 3 miles west of Chester, Massachusetts, and 0.5 miles northeast of Bonny Riggs Corner. This multipurpose flood prevention and fish and wildlife structure will have total storage capacity of 1,103 acre feet. There will be 579 acre feet for flood prevention, 521 acre feet for fish and wildlife, and 3 acre feet for sediment. The fish and wildlife capacity is made up of 425 acre feet for low flow augmentation and 96 acre feet for a wildlife pool. Principal features are shown on Figure 7.

The emergency spillway is planned in earth cut on the left abutment. The principal spillway will incorporate features to release the low flow augmentation waters and the normal stream discharge from the colder water near the bottom of the reservoir. Also, these features will provide for the regulation of the wildlife pool water levels.

The low flow pool will have a maximum surface area of 60 acres at elevation 1520. The depth of drawdown will be 9.5 feet or to the elevation of the wildlife pool. The surface area of the wildlife pool will be 25 acres with 12 acres from 0 to 3 feet in depth. Public access will be provided from Route 8 along an existing unimproved road to the pool area.

Shaker Site Reservoir

The Shaker Site is located on Shaker Mill Brook about 1.5 miles west of Becket, Massachusetts, and 0.5 miles southwest of the intersection of the Brooker Hill and McNarney Roads. This multipurpose flood prevention, fish

and wildlife structure will have 1,139 acre feet for floodwater storage, 771 acre feet for fish and wildlife storage and 5 acre feet for sediment storage for a total capacity of 1,915 acre feet. The fish and wildlife capacity is made up of 666 acre feet for low flow augmentation and 105 acre feet for a fishery pool. The maximum surface area of the low flow augmentation pool at elevation 1603 will be 49 acres. The drawdown depth will be 23 feet or to the elevation of the fishery pool at elevation 1580. The 14 acre fishery pool will have a maximum depth of 35 feet, with 16% of the pool over 15 feet in depth. Principal features are shown on Figure 8.

The emergency spillway, located in a natural saddle on the left side of the dam, is planned in earth cut. A dike will be constructed in a low saddle on the right side of the reservoir. Access to the reservoir will be from Brooker Hill Road through the October Mountain State Forest.

Upper Coles Site Reservoir

The Upper Coles Site is located on Coles Brook about 2.5 miles northwest of Middlefield Center, 0.5 miles northwest of the intersection of West Hill and Becket Roads and 1.5 miles upstream from the Coles Site Reservoir. This multipurpose flood prevention and fish and wildlife structure will have a total capacity of 3,267 acre feet. This includes 1,187 acre feet for flood prevention, 2,077 acre feet for low flow augmentation for fish and wildlife, and 3 acre feet for sediment storage. The maximum surface area of the low flow pool will be 139 acres with a drawdown depth of 22 feet. Principal features are shown on Figure 9.

The emergency spillway is planned in rock cut on the left abutment. The principal spillway will incorporate features to permit the normal water discharge and the low flow augmentation water to be drawn from the colder water near the bottom of the reservoir. A small existing dam at the site will be removed.

Access to this reservoir will be along an existing road that leads to the site from the West Hill Road. Adequate widths along each bank of Coles Brook, from the Upper Coles Site Dam downstream to the Coles Site Reservoir, will be purchased or otherwise acquired to provide access for stream fishing.

Upper Factory Site Reservoir

The Upper Factory Site is located on Factory Brook, about 2.5 miles northwest of Middlefield Center, 0.5 miles west of Skyline Trail and 2 miles upstream from the Factory Site Reservoir. This will be a multipurpose flood prevention, fish and wildlife structure. Of the total storage capacity of 2,320 acre feet, 1,107 acre feet is for flood prevention, 1,207 acre feet is for fish and wildlife, and 6 acre feet is for sediment storage. The fish and wildlife capacity consists of 803 acre feet for low flow augmentation and 404 acre feet for a fishery pool. The maximum surface area of the low flow augmentation pool will be 73 acres, with a drawdown depth of 16 feet. The surface area of the fish pool will be 34 acres with 43 percent of the surface area over 15 feet and a maximum depth of 35 feet. Principal features are shown on Figure 10.

The emergency spillway is planned in earth on the right abutment. Access will be provided to the reservoir along an abandoned logging road from the Skyline Trail.

Walker Site Reservoir

The Walker Site is located on Walker Brook about 3 miles west of Chester, Massachusetts, and 0.5 miles northeast of Bonny Riggs Corner. The pool areas cross Route 20. This multipurpose flood prevention and fishery structure will have 2,110 acre feet for flood prevention, 432 acre feet for fish and wildlife and 8 acre feet for sediment storage for a total storage capacity of 2,550 acre feet. The fish pool will have a surface area of 35 acres with 40 percent of the area over 15 feet in depth. The maximum depth of the fish pool will be 25 feet. Principal features are shown on Figure 11.

The emergency spillway is planned in earth on the right abutment through a gravelly area adjacent to Route 20. The excavation from the top ten to fifteen feet can be used for fill to raise Route 20 across the pool. The primary source of borrow material for the dam will be from the left side of the reservoir area. Route 20 will be raised across the flood pool to a minimum elevation of 1216. During the raising of this road, Route 20 will be relocated slghtly to realign the road where it crosses the pool. Two bridges will be modified or replaced. An abandoned barn within the flood pool will be removed. Access will be from Route 20.

Channel Improvement

Channel improvement will supplement the eleven floodwater detention structures to provide protection for two urban areas along the West Branch of the Westfield River from a 100-year flood. This improvement consists

of enlarging the existing river channel in the Towns of Huntington and Chester. Figures 13, 15 and 16 show pertinent information and Table 3A shows the structure data.

The channels will be excavated in the older terrace sand and gravel of the flood plain of the river. Erosion and scouring of the present river bottom is controlled by bedrock ridges in the stream bottom. Bedrock is expected to be close to the stream bottom.

Design velocities are considered to be non-erosive due to the presence of bedrock and the armor-plated bottom, and the placement of protective riprap on the streambanks where needed.

Allowance has been made for appurtenant structural features to conduct surface and other water into the improved channels. The kind and number of appurtenances will be determined in final design.

The channel improvement in Huntington will consist of increasing the hydraulic capacity of the existing channel for approximately 1850 feet. The excavated spoil will be placed on or adjacent to the streambank and protected by vegetation. The footings of a bridge across the channel will be protected. A partially demolished mill dam, constructed above a rock ledge, will be removed. The rock ledge will be excavated to allow flood flows to pass without overtopping the streambanks. The volume of rock to be excavated will be determined after detailed geologic investigations. The excavated channel side slopes will be protected by riprap or vegetation.

The channel improvement in Chester will consist of increasing the hydraulic capacity of the existing channel for approximately 1650 feet in the vicinity of the Hamilton Emery and Corundum Company. The excavated spoil will be placed on the streambank and protected by vegetation. The footings of a bridge across the channel will be protected. The excavated channel side slopes will be protected by riprap or vegetation. A cost allowance has been made for the expected rock excavation in this reach.

During final design, the Division of Fisheries and Game will be consulted to reduce, insofar as possible, any streambed modifications that would result in the loss of carrying capacity for fish.

EXPLANATION OF INSTALLATION COSTS

Land Treatment Measures

Estimated costs for installation of land treatment measures are summarized in Table 1. These costs are estimates of all costs associated with establishing the measures, including cost-sharing through the Agricultural Conservation Program.

Estimates for land treatment kinds and amounts are based upon surveys of watershed lands and technical guides for the area. All costs reflect current and local prices for the operations, services and materials involved in each practice. The estimated technical assistance costs for all measures are based upon an analysis of the costs for planning and applying similar practices and costs for soil surveys and interpretations.

Structural Measures

Estimated costs to install structural measures are shown in Tables 1 and 2. These installation costs include construction, engineering services, land rights and project administration.

Construction Costs

Cost estimates, prepared for each structural measure, were based on the preliminary designs. The most economical final design for each structure will be prepared which most nearly meets the project objectives. The construction cost for each structural measure is based on the engineer's estimate of quantities required and 1968 unit constructions costs applicable to the area. The product of the estimated quantities and unit costs were increased by 15 to 25 percent for contingencies, depending upon the nature of the work, intensity of site investigations and possibility of encountered latent conditions during construction.

The estimated unit construction costs were obtained from an analysis of comparable contract unit prices for similar construction in the Commonwealth. Allowances were made for special construction features at individual sites. These features are explained under "Works of Improvement to be Installed".

Engineering Services Cost

The cost of engineering services includes all costs associated with surveys for design, geologic investigations, final design and preparation of plans and specifications. Geologic investigations may include test pits,

seismic, additional borings and permeability tests at the dam site and in the pool area, and laboratory analyses of soil samples. Costs for geologic investigations were based on the estimated amount of studies required for each structural measure and recent costs for similar work in Massachusetts. All other engineering services costs were based on the cost of installing comparable structures in other projects in the Northeast.

The engineering services costs for the recreation facilities include cost of geologic investigation for water supply and sewage disposal, cost of architectural and engineering services and incidental services required for review of designs, routine surveys and assistance to consultants.

Land Rights Costs

Land rights costs consist of the estimated value of land and water rights to be acquired for project purposes; legal, survey and other costs associated with their acquisition; and cost of relocating or modifying existing facilities. All land rights costs will be borne by other funds. The value of approximately 1,300 acres of public land was based on the income foregone. These public lands, owned by the Commonwealth and administered by the Department of Natural Resources, will be dedicated to the purposes served. About 5,900 acres of private lands, required for the installation of the works of improvement and for future utilization of the sites, will be acquired by either the Massachusetts Water Resources Commission or the Department of Natural Resources.

The cost for relocation or modification of existing facilities includes the cost for changing or removing roads, bridges, utilities and buildings, plus associated engineering services costs.

Project Administration Costs

Project administration costs are the administrative costs associated with the installation of structural measures. These costs include administration of contracts, construction surveys, necessary inspection services during construction to insure that structural measures are installed in accordance with the plans and specifications and other associated costs. Each party to the plan will be responsible for those project administration costs it incurs.

Cost Allocation and Cost Sharing

Construction costs and engineering services costs for the multipurpose reservoirs were allocated to the purpose served by the Use-of-Facilities

method. For the Cushman site, the addition of the design storage was to achieve a more economical structure, therefore, this storage was not included for cost allocation purposes. All land rights costs for the multipurpose reservoirs were allocated to fish and wildlife or recreation uses. Cost of recreation facilities was allocated to recreation. All costs of the channel improvement and the construction and engineering services costs for the single purpose flood prevention structures were allocated to flood prevention. One half of land rights costs for these structures was charged to flood prevention and one half to non-project costs for other uses.

Sharing of project costs between P.L. 566 funds and other funds is in accordance with the provisions of Public Law 566, 83rd Congress, 68 Stat. 666, as amended, and the Policy Statement of the Secretary of Agriculture. The construction costs allocated to flood prevention for all works of improvement will be borne by PL-566 funds. The construction costs of the nine multipurpose structures allocated to recreation or fish and wildlife and the recreation facilities will be shared 50 percent by PL-566 funds and 50 percent by other funds.

The engineering services costs for all works of improvement, except for the recreation facilities, will be borne by PL-566 funds. For the recreation facilities, costs for geologic investigations for water supply and sewage disposal will be shared 50 percent by PL-566 funds and 50 percent by other funds. All other engineering services costs associated with the recreation facilities will be borne by other funds.

The Sponsors will be solely responsible for contract administration costs. Costs of land rights will be borne entirely by other funds.

Table 2A shows a summary of costs and cost sharing for the structural works of improvement.

Fund Obligations

The estimated obligation of total project funds for land treatment and structural measures for each fiscal year during the installation period is as follows:

FISCAL YEAR	MEASURE	PL-566 FUNDS	OTHER FUNDS	TOTAL
First	Land Treatment	4,607	12,786	17,393
	Structural	178,929	1,148,120	1,327,049
Second	Land Treatment	5,707	15,286	20,993
	Structural	431,291	130,738	562,029
Third	Land Treatment	4,807	14,486	19,293
	Structural	641,107	459,672	1,100,779
Fourth	Land Treatment	4,808	15,586	20,394
	Structural	605,588	240,841	846,429
Fifth	Land Treatment	3,908	14,186	18,094
	Structural	1,234,872	618,316	1,853,188
Sixth	Land Treatment	4,008	12,386	16,394
	Structural	232,727	27,451	260,178
Seventh	Land Treatment	2,208	9,686	11,894
	Structural	208,778	4,500	213,278
TOTAL		3,563,345	2,724,020	6,287,365

EFFECTS OF WORKS OF IMPROVEMENT

Installation of treatment measures included in this plan will accomplish the stated objectives of the Sponsoring Local Organization.

The works of improvement will reduce the intensity and frequency of flooding in the damage areas along the West Branch of the Westfield River. Land treatment measures to be installed on individual farms and rural ownerships will also contribute to conservation use of water, soil and other farm resources. No additional land will be brought into cultivation as a result of this project.

The other uses included in the floodwater retarding structures will provide for effective regulation of summer flows in the river, will create lakes

for fishing, hunting and recreation, and will provide a recreation complex for outdoor recreation, all of which will contribute materially to the economic development and stability of the watershed.

Effects of Land Treatment Measures

Land treatment measures are part of an integrated approach toward alleviating flood and sediment damage problems. These measures will reduce flood runoff and sediment production at its source on the upland areas of the watershed. Also, land treatment measures on other lands will contribute to the development of recreational and wildlife areas on private lands.

Land treatment measures on pasture and hayland will also improve forage production and the hydrologic condition of these lands. Forage production, primarily used as pasture for dairy herds, will continue to be the main farming endeavor. There are no surplus crops grown in this watershed and the land use is expected to remain essentially the same. Land treatment on the miscellaneous land will make possible the development of on-farm recreational facilities and will enhance the fish and wildlife potential of the watershed.

The preparation of Town Natural Resource Inventories and participation in the planning process will insure the orderly and effective development and conservation of the town's natural resources. The implementation of these plans will contribute to maintaining and improving environmental quality by the conservation of natural resources to enhance the environment, by the multiple use of these resources for active and passive recreation and by the production of products useful to the people.

The forest land treatment measures will improve the hydrologic condition of the forest land. This will result in reducing sediment and retarding storm runoff. Also, proper management and continued fire protection will increase the productivity of the forested areas and will contribute to the economy of the watershed.

Effects of Floodwater Reduction Measures

The works of improvement included in this plan will provide protection from a 100-year frequency flood to most of the residential and commercial areas located along the West Branch of the Westfield River and its tributaries. The other areas will receive flood protection to varying degrees. The total reduction of floodwater damages with the installation of the project is estimated to be 95 percent. In the six reaches, damages

will be reduced from 75 percent to 100 percent. The average annual damages "with" project are shown on Table 5 by types and amounts. These remaining damages occur to scattered residences and commercial establishments and industries. With proper flood plain management, future flood losses would be largely eliminated. Damages and benefits for floods greater than the 100-year frequency event were not evaluated.

It is estimated that the peak flood flows will be reduced by 35 percent at the mouth of the watershed. The 100-year frequency flood stages in Reach 1 will be reduced by 2.3 feet, and in Reach 5, by 3.0 feet. Damages will be reduced by 99 percent in Chester and 94 percent in Huntington. In the other reaches, flood stages will be reduced from 1.9 feet to 3.0 feet and damages reduced by 75 percent to 100 percent. For location of damage reaches, see Figure 14. Average annual damages "with" and "without" the project are shown on Table 5.

Also, the proposed project will reduce flood damages to the New York Central Railroad, county and state roads and bridges, utilities and other structures in the watershed. These are service-type facilities and any interruptions in their uses will adversely affect a large number of people living in and out of the watershed.

The area along the Westfield River from Huntington to Westfield will also benefit from the project. The project measures will reduce flood flows through this area in varying degrees. Damage reduction benefits were based on information provided by the Corps of Engineers, together with hydraulic studies made from Huntington downstream to Westfield.

Effects of Recreation Measures

The Factory Recreation Development will provide for picnicking, camping, swimming, fishing, nature study and other outdoor recreational activities. The recreation facilities to be installed adjacent to the Factory Site Reservoir will provide a base for the use and enjoyment of the other multipurpose reservoirs. This recreation development is expected to provide about 246,000 user days annually.

This development will provide capacity for a peak use of 3,750 visitors on any day during the normal 82 day recreational season or from about the middle of June to Labor Day.

The Factory Recreation Development will also provide a base for future development of additional recreational measures on state lands around the Factory Site Reservoir. This development, with the planned recreation facilities, will serve to enhance the area for use by summer residents, attract tourists to the area and serve to increase the economy of the watershed.

The base from which this development will draw visitors is defined as being within the periphery of an area of two hours driving time or within 100 miles of the site. The present estimated population of this area is 10,000,000 people.

Effects of Fish and Wildlife Measures

The fish and wildlife resource improvements will greatly enhance the fishery and wildlife resources of the watershed and surrounding towns by creating a suitable habitat for trout in lakes, improving fish habitat in the West Branch of the Westfield River and selected tributaries, and creating wetland habitat for wildlife, particularly waterfowl.

The water resource improvements at the Cherry, Coles, Shaker, Upper Factory and Walker Site Reservoirs will be managed primarily as trout fisheries. These five lakes, with a total surface area of 205 acres, will have a trout fishing pressure of approximately 10,400 fisherman trips annually.

The water resource improvements at the Cushman and Rudd Site Reservoirs will provide the needed water, food and cover to attract wildlife, particularly waterfowl, to the area. It is estimated that these lakes will provide about 380 hunter trips annually.

The water storage included in the Rudd, Shaker, Upper Coles and Upper Factory Site Reservoirs for low flow augmentation will provide for regulating and increasing the summer low flows in Cole Brook, Factory Brook, Shaker Mill Brook, Yokum Brook and the West Branch of the Westfield River. This low flow augmentation will improve the trout habitat and lengthen the fishing season, thereby improving trout stream fishing. The modifications of the principal spillways will permit the discharge of the normal stream flow volume, the runoff from minor storms and the release of the low flow augmentation waters by drawing from the cooler layers of water near the bottom of the reservoir. This will produce stream temperatures below the normal summer conditions for the streams below the structures.

With present conditions, the summer flow of the West Branch of the Westfield River decreases to about ten cubic feet per second. With the project installed, the average summer flow will be maintained at about 50 cubic feet per second for at least fifty percent of the years. The Massachusetts Division of Fisheries and Game estimates that with increased summer flow, longer fishing season and higher yearly stocking, the annual user days for trout stream fishing will increase from 3783 yearly to 9767 yearly. The Division also estimated that the annual user days will increase by 30 percent by the year 1977 and 100 percent by the year 2000. Although the stream augmentation will result in fisheries benefits downstream from Huntington, these benefits were not identified nor used for project justification.

In addition to the benefits from the primary purpose for which water storage was included in the multipurpose sites, these sites will have other fish and wildlife and recreation benefits brought about by the impoundment of water and preservation of natural areas. For example, the Cushman, Rudd and Upper Coles Site Reservoirs will have an estimated warm water fishing pressure of 3280 angler trips annually. Also, these lakes will provide many areas for nature study, hiking, birdwatching and other passive outdoor recreation activities. Each multipurpose site will also provide additional benefits from wildlife habitat development or hunting or trapping and harvest of furbearers or a combination of these activities. It is estimated that the multipurpose sites will provide for 392 user days annually for trapping, 931 user days for bird and nature study and an annual harvest of pelts from furbearers of $606.

The fish and wildlife resources improvements, considered to be a highly important and integral part of this plan, provide essential economic, recreational and aesthetic benefits. The lakes in the multipurpose reservoirs will tend to provide approximately the same wildlife habitat as present beaver flowages, but on a more permanent basis. The flood prevention sites will provide excellent woodland openings that will improve game habitat. Thus, it appears that while some game habitat will be inundated, the larger perimeter, greater permanancy and management potential will greatly increase the game habitat.

PROJECT BENEFITS

Major economic changes will be produced by the installation of this project. With a constant or diminishing level of activity in manufacturing, declining farm units and other economic and social limitations which hinder the development of the watershed, the economy is generally declining. This project offers an effective and practical means of rehabilitating the watershed, developing the recreational potential and raising the income of the residents to levels which will accelerate the development of a stable or rising economy.

In addition to monetary benefits from the project measures, the project will tend to improve public health, increase employment security, lessen hazards to life and provide a sense of stability to the communities.

The combined program of land treatment and structural measures will reduce the average annual floodwater damages by $73,670, of which $72,882 will result from the system of structural measures.

Indirect benefits attributable to the structual measures were estimated to be $14,734. These benefits result from interrupted services, loss of wages, increased expense of rerouting traffic, losses of income by businesses and other such losses.

Secondary benefits from a national viewpoint were not considered pertinent to economic evaluations and, therefore, were not evaluted. The local secondary benefits were considered to be equal to ten percent of the direct primary benefits, or $56,429.

The water impounded in the Factory Site Reservoir and the recreation facilities installed around the pool will be used extensively. The Department of Natural Resources estimated that the total benefits from the Factory Recreation Development will be $424,584 per year. This includes benefits of $55,584 annually for the fish and wildlife pool and benefits of $369,000 annually for the recreation facilities.

Water resource improvements at the eight multipurpose fish and wildlife site reservoirs will have a combined total annual benefit of $66,820.

COMPARISONS OF BENEFITS AND COSTS

The overall benefit-cost ratio for the project is 1.8 to 1.0 with annual benefits of $635,291 and annual costs of $361,669. Without the inclusion of secondary benefits, the benefit-cost ratio is 1.6 to 1.0.

In addition, the project will produce downstream benefits from the confluence with the Middle Branch of the Westfield River to the North Elm Street Bridge in the Westfield of $4,880 annually. These benefits were not used for project justification.

The annual benefits, annual costs and benefit-cost ratio are shown in Table 6.

PROJECT INSTALLATION

This plan will be carried out as a joint undertaking of non-Federal interests and the Federal Government. Non-Federal interests include individual landowners; the Berkshire Conservation District; the Hampden Conservation District; the Hampshire Conservation District; the Massachusetts Department of Natural Resources, Division of Conservation Services,

Division of Fisheries and Game, and Division of Forests and Parks; the Massachusetts Water Resources Commission; and the Westfield River Watershed Association. Participating Federal agencies include the Soil Conservation Service and the Forest Service of the U. S. Department of Agriculture and the Bureau of Sport Fisheries and Wildlife of the U. S. Department of Interior.

Sponsoring organizations will acquire necessary land rights, execute agreements with owners of private lands for installation of land treatment measures, provide the non-Federal share of the installation cost of strucural measures, and cooperate with other local, State and Federal agencies concerned with the project. The Sponsoring Local Organization, the Massachusetts Water Resources Commission and the Massachusetts Division of Fisheries and Game will enter into an agreement whereby the Commission and the Division will assume the responsibilities of the Sponsoring Local Organization as outlined in the agreement. This agreement is shown in Appendix B.

The Berkshire, Hampden and Hampshire Conservation Districts are empowered to enter into agreements with landowners and operators to apply land treatment measures within their respective Districts.

The Massachusetts Department of Natural Resources is the State Agency charged with the development, enhancement and preservation of the natural resources within the state boundaries. The Department will give high priority to this watershed and will assist technically and financially on behalf of the Commonwealth to the extent practicable.

Responsibilities for Installation

In order to coordinate the installation of the accelerated land treatment and structural measures provided in the plan and the going conservation programs within the watershed, close cooperation and specific responsibilities are required of private interests, the sponsors, and local, state, and federal agencies assisting in this project.

The Berkshire, Hampden and Hampshire Conservation Districts will:

1. Continue the going program of the Districts within the watershed at the rate which existed prior to the development of this work plan.

2. Provide the local leadership to insure the scheduled installation of the accelerated land treatment measures on private and state lands.

The Massachusetts Department of Natural Resources will:

1. Acquire all needed land rights appropriate for public outdoor recreation in conjunction with the lands acquired by the Massachusetts Water Resources Commission.

2. Furnish the non-Federal share of the construction cost for the Factory Site Reservoir and recreation facilities.

3. Provide the architectural and engineering services for the design of the Factory recreation facilities.

4. Furnish the project administration costs it incurs for the construction inspection of the structural measures.

The Massachusetts Division of Conservation Services will:

1. Maintain liaison with sponsor's and state and federal agencies participating in the project to the end that unified effort and coordinated action will produce the most effective results.

2. Consult with and assist the sponsoring organizations and local, state, and federal agencies, in making desirable revisions or amendments of this plan if and when circumstances dictate.

The Massachusetts Division of Forests and Parks will:

1. Install necessary land treatment measures to insure that State Forest land is adequately treated to minimize erosion and retard runoff.

2. In cooperation with the U. S. Forest Service, furnish techical assistance to private landowners for the installation of forest land treatment measures.

3. Construct hiking and nature study trails throughout the state owned areas around the Factory Recreation Development.

The Massachusetts Division of Fisheries and Game will:

1. Develop the fish and wildlife potential of the areas of land obtained for project pruposes.

2. Install access roads and parking areas at the eight multipurpose fish and wildlife reservoirs.

3. Install sanitary facilities at the Cherry, Upper Factory and Walker Multipurpose fish and wildlife reservoirs.

The Division of Water Resources, Massachusetts Water Resources Commission, consistent with authorities and funding authorized under Chapter 634 of the Acts of 1968, as amended; and as necessary to meet the objectives included in this work plan, will:

1. Survey and acquire all needed land rights for installation of all structural measures.

2. Act as Contracting Local Organization for the construction of the structural measures included in this plan.

3. Furnish the non-Federal share of the construction cost of all structural measures, except for the Factory Recreational Development.

4. Furnish the project administration costs it incurs for the construction inspection of structural measures.

The Soil Conservation Service will:

1. Furnish technical assistance through the Berkshire, Hampden and Hampshire Conservation Districts to landowners and operators for installation of open land treatment measures.

2. Furnish the engineering services for design surveys, geologic investigations, designs, construction plans and specifications for the installation of the structural measures except for the recreational facilities.

3. Furnish the project administration costs it incurs for the construction inspection of structural measures.

4. Provide construction funds for the project in accordance with the cost sharing set forth herein or as revised by mutual agreement.

The U. S. Forest Service will:

Through and in cooperation with the Massachusetts Department of Natural Resources, Division of Forests and Parks, furnish technical assistance to landowners for the installation of forestry measures on privately-owned lands.

Schedules for Installation

Land Treatment Measures

Open land treatment measures will be installed over the project period of seven years by individual landowners with technical assistance provided by the Soil Conservation Service in cooperation with the Berkshire, Hampden and Hampshire Conservation Districts. On private forest land, treatment measures will be installed by the landowners with technical assistance provided by the Massachusetts Department of Natural Resources, Division of Forests and Parks, in cooperation with the U. S. Forest Service. The Division of Ferests and Parks will install the land treatment measures on their holdings.

Installation of accelerated land treatment measures which have measurable effects on project objectives will begin during the first year of the project and will be completed during the project period. The going conservation program will continue at least at the same rate that existed prior to development of this plan.

To assure the establishment of land treatment measures in the installation period, the Conservation Districts will endeavor to adhere as closely as practical to their schedule of installation.

The Districts will provide leadership in furnishing information to the individual owners within the project and to the general public.

Structural Measures

Project structural measures will be installed during the project period approximately according to the following schedule:

First Year

Make geologic investigations on Upper Factory, Factory, Recreation Facilities, Upper Coles, Coles and Shaker Sites. Acquire land rights for Upper Factory, Factory and Upper Coles Sites. Make field surveys and prepare designs and contracts for Upper Factory Site.

Second Year

Make geologic investigations on Brooker, Rudd, Walker, Cherry, Cushman and Blandford Sites. Acquire land rights for Coles, Shaker and Brooker Sites.

Make field surveys and prepare designs and contracts for Factory, Upper Coles and Coles Sites. Start construction on the Upper Factory Site.

Third Year

Make geologic investigations on Channel Improvements. Acquire land rights for Rudd, Walker, and Cherry Sites. Make field surveys and prepare designs and contracts for Shaker, Brooker and Rudd Sites and recreation facilities at the Factory Recreation Development. Start construction on the Factory, Upper Coles and Coles Sites.

Fourth Year

Acquire land rights for Cushman and Blandford Sites and Channel Improvements. Make field surveys and prepare designs and contracts for Walker, Cherry and Cushman Sites. Start construction on the Shaker and Rudd Sites.

Fifth Year

Make field surveys and prepare designs and contracts for the Blandford Site and Channel Improvement. Start construction on the Brooker, Walker and Cherry Sites and the recreation facilities at the Factory Recreation Development.

Sixth Year

Start construction on the Cushman and Blandford Sites.

Seventh Year

Construct the Channel Improvement.

FINANCING PROJECT INSTALLATION

Land treatment measures installed on private property are the responsibility of the individual landowners, utilizing cost-sharing assistance available through the Agricultural Conservation Program.

P.L. 566 funds will be provided for technical assistance needed for installation of the accelerated land treatment measures. The technical assistance for the going programs will be provided at the present rate through the Berkshire, Hampden and Hampshire Conservation Districts by the Soil Conservation Service and by the Massachusetts Division of Forests and Parks in cooperation with the U. S. Forest Service.

Non-Federal funds for the installation of the structural measures will be provided under Chapter 634, Acts of 1968, as amended, enacted by the General Court of the Commonwealth of Massachusetts. (See appendix A) This special legislation authorizes the Water Resources Commission, for all works of improvement except the Factory Recreational Development, to: acquire the necessary land rights for the structural measures; let and administer contracts; enter into agreements with the Service for individual structures; provide the non-Federal share of the structural installation costs; and operate and maintain the completed structural measures. The Department of Natural Resources, through the same legislation, is authorized the above responsibilities for the Factory Recreational Development.

Installation costs allocated to P.L. 566 funds will be from funds appropriated under the authority of Public Law 566, 83rd Congress, 68 Stat. 666, as amended. This work plan does not constitute a financial document for obligation of Federal funds, and financial or other assistance by the Soil Conservation Service is contingent upon the appropriation of funds for this purpose.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Operation and maintenance of land treatment measures installed on private lands will be the responsibility of the individual owners of the properties on which the measures are installed. Land treatment measures on State Forest land will be maintained by the Massachusetts Division of Forests and Parks. Technical assistance is available from the Conservation Districts, with assistance from the Service and the Massachusetts Department of Natural Resources in cooperation with the U. S. Forest Service.

Structural Measures

The local organizations and the Service will inspect each structural measure annually, after each major storm or other unusual occurrences for three years after completion of the structure. After three years, the local organizations will make the inspections. The needed maintenance will be decided at the time of the inspection. The responsible local organization will perform the needed maintenance work.

Specific operation and maintenance agreements between the Massachusetts Water Resources Commission, Division of Water Resources, and the Service for all structural measures except the Factory Recreational Development,

will be executed prior to the issuance of invitations to bid for any construction contract. The Massachusetts Department of Natural Resources and the Service will execute operation and maintenance agreements for the Factory Site Reservoir and the recreation facilities.

Multipurpose Structures

Factory Recreation Development

Reservoir Dam

The Department of Natural Resources will be responsible for the operation and maintenance for the reservoir dam. The operation and maintenance will include, but not be limited to, the removal of debris and trash, maintenance of the vegetal cover by reseeding, fertilizing, mowing and other means as necessary, control of undesirable vegetation and replacement or repair of the concrete appurtenances.

Annual operation and maintenance costs for the reservoir dam are estimated to be $1,035.

Reservoir Pool

The Division of Fisheries and Game, by agreement with the sponsors, will operate and maintain the reservoir pool for fishing. The operation will consist of annual stocking of the pool with trout and the control of the use of the pool. The maintenance will consist of periodic reclamation of the pool and control of undesirable vegetation and brush. Estimated annual operation and maintenance costs are $6,155.

Recreation Facilities

The Department of Natural Resources, Division of Forests and Parks, will operate and maintain the recreation facilities as part of the state park system. The Division of Forests and Parks, will furnish all personnel, materials and funds for the operation and maintenance of the recreation facilities. The operation will include the collection of charges, policing of the areas, servicing of comfort stations and garbage receptacles, and providing lifeguards for the swimming areas. Principal items of maintenance will include the replacement of facilities, preventive maintenance and minor repairs as needed. Annual operation and maintenance costs for the recreation facilities are estimated to be $49,785.

The total cost for the operation and maintenance of the reservoir dam, reservoir pool and recreation facilities is $56,975.

Other Multipurpose Structures

Multipurpose Dams

The Water Resources Commission, Division of Water Resources, will be responsible for the operation and maintenance of the eight other multipurpose dams. The operation and maintenance work likely to be required consists of removal of brush and debris around the dam and spillways, maintenance of vegetal cover by reseeding, fertilizing and mowing, control of unwanted vegetation and replacement or repair of the concrete appurtenances. The annual operation and maintenance costs are estimated to be $3,214.

Fish and Wildlife Resource Improvements

The Division of Fisheries and Game, by agreement with the Sponsoring Local Organization, will operate and maintain the fish and wildlife resource improvements in this watershed.

The operation will consist of, but not be limited to, such items as stocking and control of pools and streams, regulation of water levels, planting shallow areas with adapted food crops, determination of amounts and release of low-flow augmentation waters, and policing of fish and wildlife sites to remove cans, paper and other items that would contribute to poor quality environment, if not unsanitary conditions.

Maintenance will consist of, but not be limited to, the periodic reclamation of the fish pools and streams, the control of undesirable vegetation and brush, and upkeep of access roads and parking lots.

The Division of Fisheries and Game will be responsible for the operation and maintenance of the sanitary facilities installed at the Cherry, Upper Factory and Walker Site Reservoirs. To preclude the development of unsanitary conditions at the other five multipurpose fish and wildlife site reservoirs, the Sponsors will make inspections at each site at least once during or after each season of use. The Sponsors will request the Massachusetts Department of Public Health to participate in these imspections. Should these inspections show that unsanitary conditions exist at any of these structures, the Division of Fisheries and Game will install seasonal portable units, or other suitable sanitary facilities in the amount required to ensure that water quality is maintained and that operations are in agreement with State and local health laws and regulations.

The estimated annual operation and maintenance cost of the fish and wildlife resource improvements is $11,047.

Single Purpose Structures

Floodwater Retarding Structures

The Water Resources Commission, Division of Water Resources, will be responsible for the operation and maintenance of the single purpose floodwater retarding structures. The operation and maintenance will include, but not be limited to, the removal of debris, control and maintenance of vegetal cover and replacement or repair of concrete appurtenances. Annual operation and maintenance costs are estimated to be $1,606.

Channel Improvement

The Water Resources Commission, Division of Water Resources, will be responsible for the operation and maintenance of the channel improvement. The operation and maintenance will include, but not be limited to, removal of obstructions, maintenance of vegetal cover by reseeding, fertilizing or other means, control of undesirable vegetation by spraying, mowing or other means, and repairs to placed rip-rap. Estimated annual operation and maintenance costs are $650.

The total estimated annual cost for operation and maintenance of all structural measures is $73,492.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

West Branch of the Westfield River Watershed, Massachusetts

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/ PL 566 Funds	Other	TOTAL
LAND TREATMENT					
Soil Conservation Service					
Hayland	Acres to be treated	2,075		24,050	24,050
Pastureland		1,203		4,560	4,560
Miscellaneous Land		2,715		17,570	17,570
Technical Assistance			13,253	8,822	22,075
SCS Subtotal			13,253	55,002	68,255
Forest Service					
Forest land	Acres	8,910		33,000	33,000
Technical Assistance			16,800	6,400	23,200
FS Subtotal			16,800	39,400	56,200
TOTAL LAND TREATMENT			30,053	94,402	124,455
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Multi-purpose Structures	No.	9	2,033,642	989,318	3,022,960
Single Purpose Structures	No.	2	382,800		382,800
Channel Improvements	Ft.	3,500	145,450		145,450
Subtotal Construction			2,561,892	989,318	3,551,210
Engineering Services					
Soil Conservation Service			374,700	153,150	527,850
Subtotal Engineering			374,700	153,150	527,850
Project Administration					
Soil Conservation Service					
Construction Inspection			283,600		283,600
Other			307,050	9,000	316,050
Review of Plans prepared by others			6,050		6,050
Subtotal-Administration			596,700	9,000	605,700
Other Costs					
Land Rights				1,478,150	1,478,150
Subtotal-Other				1,478,150	1,478,150
TOTAL STRUCTURAL MEASURES			3,533,292	2,629,618	6,162,910
TOTAL PROJECT			3,563,345	2,724,020	6,287,365
SUMMARY					
Subtotal SCS			3,546,545	2,684,620	6,231,165
Subtotal FS			16,800	39,400	56,200
TOTAL PROJECT			3,563,345	2,724,020	6,287,365

1/ Price base 1968

July 1969

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

(at time of work plan preparation)

West Branch of the Westfield River Watershed, Massachusetts

Measures	Unit	Applied to Date 1/	Total Cost (Dollars) 2/
LAND TREATMENT			
Soil Conservation Service			
Brush Control	Ac.	15	300
Conservation Cropping System	Ac.	69	2,170
Critical Area Planting	Ac.	2	800
Ponds	No.	19	366,650
Mulching	Ac.	1	80
Pasture and Hayland Management	Ac.	375	7,020
Pasture and Hayland Planting	Ac.	148	14,350
Tree Planting	Ac.	16	960
Woodland Improvement	Ac.	219	4,755
Recreation Access Road	Mi.	.5	12,000
SCS Subtotal			409,085
Forest Service			
Management Plans	Ac./No.	245/3	340
Tree Planting	Ac.	47	3,500
Hydrological Cultural Operations	Ac.	1,662	32,930
Erosion Control	Ac.	400	2,000
Fire Control	Ac.	55,134	55,134
FS Subtotal			93,904
TOTAL			502,989

1/ Accomplishments from FY 1959 through FY 1968

2/ Price Base 1968

July 1969

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

West Branch of the Westfield River Watershed, Massachusetts

(Dollars) 1/

ITEM	Installation Cost PL 566 Funds			Installation Cost - Other Funds				Total Installation Cost
	Construction	Engineering	Total PL 566	Construction	Engineering	Land Rights	Total Other	
Multiple Purpose Structures:								
Factory								
Site Reservoir	430,830	72,700 3/	503,530	274,870	- 3/	-	274,870	778,400
Recreation Facilities	388,080	25,000 3/	413,080	383,080	150,000 3/	1,086,240	1,624,320	2,037,400
Subtotal	818,910	97,700	916,610	662,950	150,000	1,086,240	1,899,190	2,815,800
Cherry								
Site Reservoir	173,644	27,800	201,444	46,856	-	24,600	71,456	272,900
Sanitary Facilities	-	-	-	7,000	1,050	(59,400) 2/	8,050	8,050
Coles	151,554	24,000	175,554	22,446	-	9,400	31,846	207,400
Cushman	86,099	16,800	102,899	10,101	-	19,500 (57,600) 2/	29,601	132,500
Rudd	93,208	19,500	112,708	28,792	-	26,700 (9,600) 2/	55,492	168,200
Shaker	161,936	26,200	188,136	40,864	-	26,100 (251,000) 2/	66,964	255,100
Upper Coles	120,509	24,200	144,709	56,191	-	48,000	104,191	248,900
Upper Factory								
Site Reservoir	234,062	35,700	269,762	82,238	-	7,200	89,438	359,200
Sanitary Facilities	-	-	-	7,000	1,050	-	8,050	8,050
Walker								
Site Reservoir	193,720	27,000	220,720	17,880	-	193,700	211,580	432,300
Sanitary Facilities	-	-	-	7,000	1,050	-	8,050	8,050
Stream Access	-	-	-	-	-	6,660	6,660	6,660
Single Purpose Structures:								
Floodwater Retarding Structures								
Blandford	79,300	14,500	93,800	-	-	4,750 (40,800) 2/	4,750	98,550
Brooker	303,500	35,000	338,500	-	-	13,300 (11,100) 2/	13,300	351,800
Channel Improvement	145,450	26,300	171,750	-	-	12,000	12,000	183,750
Subtotal	2,561,892	374,700	2,936,592	989,318	153,150	1,478,150 4/	2,620,618	5,557,210
Project Administration			596,700				9,000	605,700
GRAND TOTAL			3,533,292				2,629,618	6,162,910

1/ Price base 1968

2/ Non project cost for additional land and land for other uses.

3/ Site investigations for water supply and sewage disposal to be borne $25,000 by PL 566 funds and $25,000 by other funds.

4/ Includes $419,300 for survey, legal fees and other costs, $184,250 for relocation or modification of facilities and value of land already owned by the Commonwealth of Massachusetts $ 22,340.

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TABLE 2A - COST ALLOCATION AND COST-SHARING SUMMARY

West Branch of the Westfield River Watershed, Massachusetts

(Dollars) 1/

ITEM	COST ALLOCATION				COST SHARING							
	PURPOSE				PL 566				OTHER			
	Flood Prevention	Fish & Wildlife	Recreation	Total	Flood Prevention	Fish & Wildlife	Recreation	Total	Flood Prevention	Fish & Wildlife	Recreation	Total
Multipurpose Structures												
Factory												
Site Reservoir	172,026	-	606,374	778,400	172,026	-	331,504	503,530	-	-	274,870	274,870
Recreation Facil.	-	-	2,037,400	2,037,400	-	-	413,080	413,080	-	-	1,624,320	1,624,320
Subtotal	172,076	-	2,643,774	2,815,800	172,026	-	744,584	916,610	-	-	1,899,190	1,899,190
Cherry												
Site Reservoir	142,773	130,127	-	272,900	142,773	58,671	-	201,444	-	71,456	-	71,456
Sanitary Facil.	-	8,050	-	8,050	-	-	-	-	-	8,050	-	8,050
Coles	146,916	60,484	-	207,400	146,916	28,638	-	175,554	-	31,846	-	31,846
Cushman	89,270	43,230	-	132,500	89,270	13,629	-	102,899	-	29,601	-	29,601
Rudd	74,712	93,488	-	168,200	74,712	37,996	-	112,708	-	55,492	-	55,492
Shaker	136,713	118,387	-	255,100	136,713	51,423	-	188,136	-	66,964	-	66,964
Upper Coles	73,127	175,773	-	248,900	73,127	71,582	-	144,709	-	104,191	-	104,191
Upper Factory												
Site Reservoir	168,960	190,240	-	359,200	168,960	100,802	-	269,762	-	89,438	-	89,438
Sanitary Facil.	-	8,050	-	8,050	-	-	-	-	-	8,050	-	8,050
Walker												
Site Reservoir	198,277	234,023	-	432,300	198,277	22,443	-	220,720	-	211,580	-	211,580
Sanitary Facil.	-	8,050	-	8,050	-	-	-	-	-	8,050	-	8,050
Stream Access	-	6,660	-	6,660	-	-	-	-	-	6,660	-	6,660
Single Purpose Structures												
Floodwater Retarding Structures												
Blandford	98,550	-	-	98,550	93,800	-	-	93,800	4,750	-	-	4,750
Brooker	351,800	-	-	351,800	338,500	-	-	338,500	13,300	-	-	13,300
Channel Improvement	183,750	-	-	183,750	171,750	-	-	171,750	12,000	-	-	12,000
GRAND TOTAL	1,836,874	1,076,562	2,634,774	5,557,210	1,806,824	385,184	744,584	2,936,592	30,050	691,378	1,899,190	2,620,618

1/ Price Base 1968

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TABLE 2B - RECREATION FACILITIES

ESTIMATED CONSTRUCTION COSTS

West Branch of the Westfield River Watershed, Massachusetts

(Dollars) 1/

Item	Number	Estimated Unit Cost	Total Construction Cost
Day Use Access Road and Parking Area	1	31,360	31,360
Camping Access Road	1	260,820	260,820
Picnic Sites with Table, Fireplace, etc.	200	224 2/	44,800
Camp Sites with Table, Fireplace, etc.	200	280 2/	56,000
Beachhouse	1	67,340 3/	67,340
Comfort Station	1	16,800 3/	16,800
Bathhouse	8	22,400 3/	179,200
Beach	2	11,200	22,400
Comfort Station	2	11,200 3/	22,400
Boat Ramp & Parking	1	33,600	33,600
Contact Station	1	13,440 3/	13,440
Observation Tower	1	28,000	28,000
GRAND TOTAL			776,160

1/ Base Price - 1968

2/ Includes Site Preparation

3/ Includes lighting and sewage disposal and water supply

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TABLE 3 - PRELIMINARY STRUCTURAL DATA
for
STRUCTURES WITH PLANNED STORAGE CAPACITY
West Branch of the Westfield River Watershed, Massachusetts

ITEM	UNIT	Blandford	Brooker	Cherry	Coles	Cushman	Factory	Rudd	Shaker	Upper Coles	Upper Factory	Walker	Total
Class of Structure		c	c	c	c	c	c	c	c	c	c	c	
Drainage Area	Sq.Mi.	0.8	2.4	2.4	1.4	1.0	4.0	2.3	3.6	2.9	3.9	8.7	33.4
Controlled	Sq.Mi.	-	3.6	-	2.9	-	3.9	-	-	-	-	-	
Curve No. (1-day)(AMC II)		71	71	71	71	71	71	71	71	71	71	71	
T_c	Hrs.	0.83	2.52	1.95	1.66	0.83	1.50	1.50	2.70	2.11	1.43	4.06	
Elevation Top of Dam	Ft.	1205.0	1474.5	1071.5	1303.5	1325.5	1392.5	1533.5	1622.5	1523.5	1519.0	1221.5	
Elevation Crest Emergency Spillway	Ft.	1201.0	1462.5	1064.0	1297.5	1320.0	1377.5	1528.0	1618.0	1516.0	1513.0	1215.0	
Elevation Crest Low Stage Inlet	Ft.	1176.0	1433.0	1050.0	1275.0	1310.0	1370.0	1520.0	1603.0	1508.0	1500.0	1184.0	
Maximum Height of Dam	Ft.	31	57	52	74	32	73	52	78	44	69	63	
Volume of Fill	Cu.Yds.	56,700	272,200	209,500	192,800	30,600	759,000	50,000	169,000	104,700	291,600	192,800	2,329,400
Total Capacity	Ac.Ft.	247	650	1,110	567	462	5,706	1,103	1,915	3,267	2,320	2,550	19,897
Sediment - 100 Year Accumulation	Ac.Ft.	1.0	7.0	7.0	4.0	1.0	6.0	3.0	5.0	3.0	6.0	8.0	51
Fish and Wildlife	Ac.Ft.	-	-	472	146	84	-	521	771	2077	1207	432	5,710
Recreation	Ac.Ft.	-	-	-	-	-	4443	-	-	-	-	-	4,443
Design	Ac.Ft.	-	-	-	-	62	-	-	-	-	-	-	62
Retarding	Ac.Ft.	246	643	631	417	315	1257	579	1139	1187	1107	2110	9,631
Surface Area													
Fish and Wildlife pool	Acres	-	-	36	12	20	-	60	49	139	73	35	497
Recreation pool	Acres	-	-	-	-	-	161	-	-	-	-	-	161
Retarding pool	Acres	72	42	56	26	59	176	84	102	154	101	105	977
Principal Spillway													
Rainfall Volume (areal)(1 day)	In.	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	
Rainfall Volume (areal)(10 day)	In.	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	
Runoff Volume (10 day)	In.	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	
Capacity of Low Stage (Max.)	cfs	30	206	120	162	30	320	125	90	136	145	530	
Frequency Operation-Emer.Spillway	% chance	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	
Size of Conduit	Dia.	30"	36"	30"	30"	30"	42"	30"	30"	30"	30"	54"	
Emergency Spillway													
Rainfall Volume (ESH)(areal)	In.	9.5	9.5	9.6	9.6	9.6	9.40	9.5	9.5	9.6	9.5	9.6	
Runoff Volume (ESH)	In.	5.90	5.90	5.99	5.99	5.99	5.82	5.90	5.90	5.99	5.90	5.99	
Type		veg.	veg. 2/	veg.	veg.	rock	rock	veg.	veg.	rock	veg.	veg.	
Bottom Width	Ft.	175	100	100	100	30	50	175	400	30	300	400	
Velocity of flow (V_e)	Ft./Sec.	1/	1/	3.2	1/	1/	1/	3.0	1/	1/	2.5	4.4	
Slope of exit channel	Ft./Ft.	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	
Maximum water surface elevation	Ft.	1/	1/	1065.2	1/	1/	1/	1528.6	1/	1/	1513.4	1216.2	
Freeboard													
Rainfall Volume (FH) (areal)	In.	22.8	22.7	22.9	22.8	22.9	22.8	22.7	22.7	22.8	22.8	22.8	
Runoff Volume (FH)	In.	18.54	18.44	18.63	18.54	18.63	18.54	18.44	18.44	18.54	18.50	18.54	
Maximum water surface elevation	Ft.	1204.9	1474.5	1071.3	1303.5	1325.4	1392.5	1533.5	1622.3	1523.2	1519.0	1221.5	
Capacity Equivalents													
Sediment Volume	In.	0.03	0.05	0.05	0.05	0.02	0.02	0.03	0.03	0.02	0.03	0.02	
Retarding Volume	In.	5.77	5.02	4.93	5.59	7.07	5.90	4.74	5.94	7.66	5.32	4.55	

1/ Emergency spillway hydrograph contained below emergency spillway crest.
2/ Vegetated, but with paved control section.

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TABLE 3A - PRELIMINARY STRUCTURE DATA

CHANNEL IMPROVEMENT

West Branch of the Westfield River Watershed, Massachusetts

Channel Name	Station	Capacity 3/		Water Surface Elev.	Channel Gradient	Channel Dimensions 4/		Velocities 5/		Excavation	Type of Improvement 6/
		Required (cfs)	Design (cfs)	(ft.)	(ft/ft)	Bottom (ft)	Depth (ft)	Aged (fps)	As Built (fps)	(CuYd)	
Chester 1/	749 + 17	9,200	9,200	628.3	Upper limit of construction			8.0	8.0		
	753 + 02	9,200	9,200	619.6	0.0133	100	6.2	12.1	12.1		CE-P
	757 + 61	9,200	9,200	616.0	0.0133	100	8.7	8.5	8.2		CE-P
	757 + 94	9,200	9,200			bridge section					CE-P
	758 + 44	9,200	9,200	615.1	0.007	80	8.6	9.8	10.7		CE-P
	764 + 22	9,200	9,200	610.9	0.007	80	8.4	11.2	12.1		CE-P
	765 + 30	9,200	9,200	609.4	Lower limit of construction			4.9	4.9	22,375	CE-P
Huntington 2/	1126 + 30	15,600	15,600	391.5	Upper Limit of construction			9.1	9.2		
	1128 + 80	15,600	15,600	388.7	0.0055	120	9.4	9.9	10.8		CE
	1136 + 26	15,600	15,600	386.1	0.0055	120	10.9	8.4	8.1		CE
	1139 + 35	15,600	15,600	385.1	0.0055	120	11.6	9.1	8.5		CE
	1139 + 90	15,600	15,600	385.0	0.0055	120	11.8	9.0	8.4		CE-P
	1140 + 26	15,600	15,600			bridge section					
	1140 + 63	15,600	15,600	381.6	0.007	120	8.8	12.5	13.4		CE-P
	1144 + 03	15,600	15,600	378.7	0.007	120	8.3	13.4	14.3		CE-P
	1144 + 88	15,600	15,600	377.4	0.007	120	7.6	14.4	14.4	18,400	CE-P
	1144 + 88				Lower Limit of construction						

1/ Drainage area 56.3 sq.mi.
2/ Drainage area 93.7 sq.mi.
3/ Channels designed for 100-year Frequency Flow.
4/ Channel side slopes 2:1.
5/ Aged "n" Value 0.040; As-Built "n" Value 0.035
6/ CE- channel enlargement; CE-P channel enlargement with side slope protection.

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TABLE 4 - ANNUAL COST

West Branch of the Westfield River Watershed, Massachusetts

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
All Structural Measures	259,855	73,492 3/	333,347
Project Administration	-	-	28,322
GRAND TOTAL	259,855	73,492	361,669

1/ Price base: Installation-1968, O&M Adjusted Long Term.

2/ 100 years at 4 5/8 percent interest

3/ Includes $49,785 for operation, maintenance, and replacement for the recreational development.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

West Branch of the Westfield River Watershed, Massachusetts

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Residential	7,694	329	7,365
Commercial	9,235	395	8,840
Highway & Bridge	16,163	692	15,471
Railroad	4,619	198	4,421
Manufacturing	37,713	1,614	36,099
Utility	1,540	66	1,474
Subtotal	76,964	3,294	73,670
Indirect	15,393	659	14,734
TOTAL	92,357	3,953	88,404

1/ Price base 1968

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

West Branch of the Westfield River Watershed, Massachusetts

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Total	3/ Average Annual Cost	Benefit Cost Ratio
	Damage Reduction	Fish and Wildlife	Recreation	Secondary			
All Structural Measures	87,458	122,404	369,000	56,429	635,291	333,347	1.9 to 1.0
Project Administration						28,322	
GRAND TOTAL	87,458 2/	122,404	369,000	56,429	635,291	361,669	1.8 to 1.0

1/ Price base 1968

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $946 annually.

3/ From Table 4.

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INVESTIGATIONS AND ANALYSES
PROJECT FORMULATION

The watershed problems were clearly defined through discussions with the local sponsors and through investigations. Project objectives of the sponsors determined the extent of the investigations and analyses necessary to the comprehensive planning of the watershed. These investigations were planned jointly by the participating agencies and sponsors and carried out to determine feasible solutions to the problems.

The objectives of the sponsors include the reduction or elimination of flood-water damage to the developed areas along the West Branch of the Westfield River and its tributaries, the utilization of the watershed area for recreation, the augmentation of selected streams during periods of low flow to improve stream fishing, providing lakes for fishing and developing wildlife habitat areas for waterfowl.

Land Treatment Measures

An investigation of land treatment needs of the watershed was made as the first increment of project formulation. This investigation consisted of a search of the Districts and Service records, field observations, and consultations with the District Supervisors, agency personnel and landowners. Land treatment measures were outlined where investigations showed a need for treatment.

Information on the hydrologic condition of the forest land and the reasons for the present condition were obtained in a series of systematically selected field plots. This information served as a basis for developing land treatment needs for the woodland.

Forest fire protection is provided by the eight towns within the watershed and the Massachusetts Department of Natural Resources, Division of Forests and Parks in cooperation with the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program. The fire loss index goal (0.20 percent) has not been exceeded and this protection is considered adequate. No increase in fire occurrence is anticipated.

The Sponsors evaluated the present and future progress of the Towns within the watershed in the development of Natural Resource Programs. It is anticipated that, with accelerated technical assistance, two towns will develop a natural resource plan for the conservation and development of the Town's natural resources during the project period.

Structural Measures

It was obvious that structural measures would be needed to supplement the land treatment measures to accomplish the objectives of the Sponsors. The primary basis for determining the structural measures to be included in this plan was to provide the maximum level of flood protection and multipurpose use within the limits of sound economic and engineering practices.

The areas of the watershed experiencing flood damages were located with the Sponsors. Studies were made in the field to determine the magnitude and frequency of the flood problem. Damage surveys were made of each of the flood areas. This flood damage information served as a basis for calculating the present annual damages and the projected future damage reductions.

Alternative measures, including those in the plan, were located on USGS Quadrangle Sheets. Available information and data were collected through the cooperative efforts of the Service, the Sponsors and other Federal, State and local agencies. Where necessary, additional surveys and investigations were planned and carried out. Costs of various alternatives were considered without regard to the relative Federal and non-Federal shares of the cost. Project measures were selected to provide the maximum net benefit with the least annual cost, including the annual operations and maintenance costs. Rather detailed investigations were carried out to determine comparative advantages of the various alternatives.

Consideration was given to including multipurpose use in each structure. Based upon the evaluation made of each site for recreation potential, the Massachusetts Division of Forests and Parks, with assistance from the Service, selected the Factory site as most suitable to meet the recreation needs determined in the State's Outdoor Recreation Master Plan. The recreation capacity and the recreation facilities, both kinds and amounts, were determined by the Division of Forests and Parks and were based upon expected use. The expected use was determined by an analysis made by the Division of Forests and Parks of similar areas under its jurisdiction and adjusted to local conditions.

The Massachusetts Division of Fisheries and Game, with assistance from the Service, the Sponsors and other agencies, determined the need for water resource improvements for fish and wildlife in the watershed. Each structure was then evaluated as to its potential for fishing, wildlife habitat development, water storage for low-flow augmentation, and recreation. Sites and capacities were selected to meet the needs for fish and wildlife based on the least cost.

Water quality tests, taken at the proposed multipurpose sites by the Massachusetts Department of Public Health, indicated that the present water quality was adequate for the planned purpose.

The total capacity required for low-flow augmentation water storage was determined by studies utilizing 31 years of streamflow records from a stream-gage at Huntington on the West Branch of the Westfield River and needs established by the Division of Fisheries and Game. The total capacity was designed to supplement low summer stream flows in the West Branch of the Westfield River and selected tributaries. Sites were selected which would benefit the maximum stream reaches. The active capacity was designed to provide for an average flow past the stream gage in Huntington of about 50 cubic feet per second at least 50 percent of the years. This total capacity required was then distributed between the sites selected based on available storage, comparison of cost per acre foot of storage, location of structures and length of tributary stream benefited.

The installation of stream improvement devices, especially in the areas of augmented flow, could increase the fishing potential. After the project is installed, the stream environment will change due to reduction of flood peaks and augmenting low flows. Consideration of any stream improvement devices will be delayed until after project installation.

A total of 25 potential structure sites were identified. Preliminary designs and cost estimates were made for each potential structure. The effect of each site, individually and in various combinations with other sites, was determined. The eleven sites included in the plan were selected on the basis of relative cost, location, multipurpose use potential and effects on flood damage reductions.

Channel improvements to supplement the retarding structures were found to be the most feasible to provide the desired degree of flood protection to two localized areas, one in Chester and the other in Huntington. Alternates considered were additional retarding structures upstream of the two areas, construction of dikes and a combination of diking and channel improvement.

ECONOMICS

Preliminary investigations by the Sponsors and the Service gave an overall picture of watershed problems. Further examination with the planning technicians provided a basis for defining major study items and served to establish survey and fact-collecting procedures. For purposes of economic evaluations and project formulation, the economic studies included flood damage investigations, determination of indirect and secondary benefits, changed land use studies, and determination of benefits from recreation and fish and wildlife use.

Flood Damage Investigations

Damage investigations included determination of nature and distribution of land and facilities subject to damage by flood runoff. Damage information was obtained by interviewing residents, local town officials, local and state highway department engineers, owners of retail establishments, and officials of manufacturing concerns, utilities and railroads. These interviews obtained information on frequency of flood occurrences and areas, kinds and amounts of flood damage. One hundred and fifty-four schedules of flood damage information were collected. These schedules, keyed to a 100-year frequency storm, estimated flood damages by one-foot increments up to the point where there were no remaining damages.

The damage information gathered through surveys, interviews and examination of flood damage areas formed the basis for establishing an annual damage base for each type of flood damage. The annual damage base was converted to long-term prices and costs using appropriate conversion factors.

Eleven damage reaches were established by the hydrologist, engineer and economist for their hydraulic as well as stage-damage relationship. Due to the inter-related effect of all works of improvements on the flood damage areas, all structural measures were considered to be a single evaluation unit. Stage-damage series were developed for each of the eleven damage reaches, up to the one percent chance-of-occurrence storm. Annual benefits were computed using the frequency method outlined in Chapter 3 of the Soil Conservation Service Economics Guide.

All costs incurred during the seven-year installation period were based on 1968 prices. Operation and maintenance costs were adjusted to long term values. Construction and engineering services costs for the multipurpose structures were allocated by the Use-of-Facilities method. Land rights estimates were provided by the Massachusetts Division of Forests and Parks, local real estate brokers and the Sponsors. For the multipurpose structures, land rights costs were allocated to other uses. For the single purpose structures, one half of the land rights costs were allocated as non-project costs to other uses and one half to flood prevention.

Sediment damages were not evaluated separately, but were included in the flood damage appraisals. The indirect damages were estimated to be twenty percent of the direct primary damages. Secondary benefits from a national standpoint were not evaluated. The secondary benefits which involve local, state and regional influence were estimated to be ten percent of the direct benefits.

Project effects, in the reach from Huntington downstream to the City of Westfield, were determined by computing the resulting reduction in flood stage brought about by project measures from a 100-year frequency storm event. Annual benefits resulting from this stage reduction were taken from stage damage curves prepared by the Corps of Engineers for its Westfield Flood Protection Project. Althrough these benefits were identified, they were not used for project justification.

Recreation Benefits

The evaluation of recreation benefits for the Factory Recreation Development is based on material furnished by the Massachusetts Division of Forests and Parks. This material included: delineation of primary demand area; estimated demand rates; peak and average user-days for the facilities; and estimated benefits for the user-days. Unit values per visitor day are in accordance with criteria set forth in Supplement No. 1, Evaluation Standards for Primary Outdoor Recreation Benefits. The estimated visitor days and benefits for the Factory Recreation Development are shown below:

Activity	Estimated Visitor Days	Annual Benefits
Picnicking	92,250	$138,375
Camping	61,500	$ 92,250
Hiking and Nature Study	92,250	$138,375
TOTAL	246,000	$369,000

Fish and Wildlife Benefits

Benefits from the fish and wildlife resource improvements were provided by the Massachusetts Division of Fisheries and Game. This included fish and wildlife benefits accruing to the Factory Site Reservoir. Benefits were estimated for: trout pond fishing, trout stream fishing, warm water pond fishing, hunting, trapping, harvest of furbearers, birdwatching and nature study, and value of wildlife habitat development.

Angler day benefits furnished by Massachusetts Division of Fisheries and Game, were based on Supplement No. 1, Evaluation Standards for Primary Outdoor Benefits.

Value of wildlife habitat was based on the assumption that benefits equal those incurred in creating comparable size marshes and calculating benefits solely on the basis of recreational use. Costs for creating marshes were provided the Division of Fisheries and Game by the U. S. Wildlife Service.

Hunting benefits were calculated on the estimated number of potential blinds that would be in use on twenty week days and five weekends of hunting prior to freeze-up.

Benefits from the low-flow augmentation were based on the expected increase in stream fishing angler days on those streams presently stocked and on those streams not presently stocked, but would be with the low-flow augmentation water.

The estimated annual user days for the major fish and wildlife activities and the total annual benefits from the fish and wildlife resource improvement at each site are shown below. The total annual benefits include the value of the wildlife habitat, trapping and value of the harvest of furbearers.

Site	Trout Pool Fishing	Warmwater Fishing	Hunting	Nature Study	Total Annual Benefits
	(Days)	(Days)	(Days)	(Days)	(Dollars)
Cherry	2,880	--	40	72	9,440
Coles	880	--	15	22	2,926
Cushman	--	400	180	20	2,233
Factory	13,360	--	80	322	55,584
Rudd	--	1,500	198	120	4,895
Shaker	960	--	40	98	4,308
Upper Coles	--	1,380	120	139	5,616
Upper Factory	2,880	--	80	68	10,265
Walker	2,800	--	50	70	9,185
TOTAL	23,760	3,280	803	931	104,452

The annual benefits from low-flow augmenation storage are shown below:

Reach	Reach Length	Visitor Days Without Project	Visitor Days With Project	Increase	Annual Benefits
	(Mile)	(Days)	(Days)	(Days)	(Dollars)
Main Branch	16.9	3,094	6,188	3,094	9,282
Factory Brook	3.9	300	1,500	1,200	3,600
Coles Brook	3.0	--	912	912	2,736
Shaker	2.0	201	603	402	1,206
Yokum	1.9	188	564	376	1,128
TOTAL	27.7	3,783	9,767	5,984	17,952

In addition to benefits from water-associated activities, the Massachusetts Division of Fisheries and Game estimates that the project will have substantial benefits from hunting upland game. These benefits, accruing from hunting both small and big game, would be realized primarily on the land area surrounding the Upper Factory, Factory and Upper Coles Sites. It is estimated that, with direct habitat management, the area would provide 1,200 annual hunter trips for small game and 306 annual hunter trips for big game having annual benefits of $4,877. If approximately ten per cent of the forest area were brought under wildlife management practices to provide about 250 acres of clearings and pheasants were released, the area would then provide 4,856 annual hunter trips for small game and 350 annual hunter trips for big game for annual benefits of $16,143. Deducting operation and maintenance costs of $10,714 annually for habitat management and release of pheasants, the net annual benefits from upland game hunting would be $5,429. Although these benefits were identified, they were not included in the annual benefits from fish and wildlife resources improvement.

HYDROLOGY

Hydrologic studies were primarily concerned with determining the present and future peak flow-runoff evaluation series for use in developing area-inundated-stage frequency relationships, evaluating the effects of land treatment measures, computing volume-duration-frequency relationships for design of structural measures and computing principal and emergency spillway design hydrographs and flood routings for structural design.

Soil type and land use data were furnished by the Soil Conservation Service. The Forest Service provided soil-cover curve numbers for the forest land in the watershed. Soil-cover complex curve numbers, present and future, were developed from these data. One set of curves was computed for the watershed since investigations indicated that similar conditions existed throughout the watershed.

Sub-watershed stream routings were developed by the computer program established in Technical Release No. 20. The West Branch of the Westfield River Watershed was divided into 37 sub-watershed areas. The watershed of the Westfield River from the confluence with the West Branch of the Westfield River to the stream gage in Westfield was also divided into 10 additional sub-watersheds. The drainage area of each sub-watershed was measured. The times of concentration, determined using ES-1015, were adjusted to agree with actual stream flow records. The average stream velocity was based on stream channel survey data and the routing coefficients determined. A twenty-four hour evaluation storm with 6.3 inches of rainfall was routed through the watershed and downstream of Westfield. Other

storms routed were: the 1948 natural storm, the 1955 natural storm, and the Standard Project Flood obtained from the Corps of Engineers' interim report dated November 6, 1959. These four storms were routed for present conditions and for future conditions. The soil-cover complex curve number for the watershed with land treatment measures installed was used in all of the computer stream routings. The two natural storms were routed to Huntington to check the routed hydrographs with the stream gage record. A discharge frequency curve was developed from the 31 years of record available on the stream gage at Huntington. The annual peak discharge was used in the series. The annual series computing method described in Part 3.18 of Supplement A, Section 4, Soil Conservation Service National Engineering Handbook was used to prepare the frequency curve.

The one-day evaluation storm routing was used with the stream gage discharge frequency curve to compute the present and future discharge frequency curves for each of the damage reaches within the West Branch of the Westfield River Watershed.

Field surveys for development of stream and valley cross-sections were made from the confluence with the Westfield River at Huntington to the first railroad bridge above Chester. Field surveys were also made on Walker Brook in Becket. Water surface profiles were developed on the West Branch from Huntington through Chester by the "Step" method described in Part 3.14 of Supplement A, Section 4, Soil Conservation Service National Engineering Handbook. These profiles and the 100-year present and future profiles were developed. Rating curves were also developed for each cross-section. A typical cross-section was located in each damage reach and used for the evaluation studies.

Floodwater storage capacity provided and the design hydrographs developed for each reservoir were in accordance with Soil Conservation Service standards set forth in Engineering Memorandum SCS-27 and in Part 3.21 of Supplement A, Section 4, Soil Conservation Service National Engineering Handbook. To insure infrequent operation of emergency spillways, floodwater storage capacity is provided to control the 100-year frequency storm runoff volume. A synthetic storm of greater than 100-year frequency, modeled on the "Diane" 1955 storm, was used to select the flood capacity-release rate relationship for the dam sites. In all cases, the capacity required, using the same stage-discharge relationship, was greater than that required to control the 100-year frequency storm.

An analysis was made of stream flow records from the U. S. Geological Survey's stream gaging station on the West Branch of the Westfield River at Huntington. This analysis was used to estimate the amount of storage required to provide

flow augmentation for maintaining an average of 50 cfs for the average year at the Huntington gaging station. The flow volume for the critical period (generally June through mid September) for the 31 years of record were placed in a frequency array. This array showed that 1958 represented the mean dry year (50% chance). A detailed low flow analysis was made for this year which indicated that an average stream flow of about 50 cfs could be maintained through September 15. A similar analysis was made of 1964, the driest year of record. Stream flows during this year were maintained at about 50 cfs until August 1, when the low-flow augmentation storage was depleted.

This analysis assumed that when stream flows at the Huntington gage varied from the 45 to 65 cfs range, discharge adjustments were made at the augmentation storage reservoirs. On an average year, about twenty flow adjustments will be necessary during the release period.

The Division of Fisheries and Game will be furnished a discharge release schedule to coordinate releases from the four augmentation storage structures. This schedule will be based upon flows at the Huntington gage and available storage in the structures. Should it become desirable to increase flows or period of release, suitable adjustments will be made in the schedule.

Reservoir operations studies of each low-flow augmentation pool were used to determine if the pool would refill to capacity each year prior to commencement of the next year's operation. These studies, based on thirty-one years of records, showed that under normal conditions each pool would have refilled before the next year's operation began.

Reservoir operations studies were also made of the other multipurpose fishery pools and recreation pools to determine whether additional storage was required to maintain the pools at the desired minimum elevation. These studies showed, for each year of record, that the reservoir pools would maintain approximately the same elevation the year round and no additional storage was required.

GEOLOGY

General

The geology of the watershed can generally be characterized as being in an area of Pre-Cambrian gneiss to silurian schist bedrock with some minor exceptions. One exception is the limestone or marble unit found at the Factory Site. The

bedrock is overlain by glacial debris which mainly consists of englacial drift which is generally permeable and loose and has been let down on the surface by the melting of the glacial ice. The englacial drift generally is sand and gravel with some fines, cobbles and boulders. The glacial till is dense, silty sand or gravel; generally is impervious and may contain cobbles and boulders. The valley fill section is recent alluvium consisting of silt, sand, gravel, cobbles and boulders which may contain varying amounts of organic debris.

Foundation Inverstigations

Preliminary geologic investigations were made to determine the apparent sub-surface conditions and engineering characteristics of foundation materials at each site. Data from these investigations were used to determine the geologic feasibility of the site and in preparing the cost estimate.

Investigations included core-drilling two or more holes along the proposed centerline and seismograph surveys in the emergency spillway and borrow areas at each site. Soil samples were collected and classified by sieve analyses and visual inspection. Profiles were prepared of each dam centerline using the geologist's interpretation of available data to show the approximate horizons and extent of various materials encountered during drilling and surficial mapping.

Studies and investigations made of site conditions indicate that the dams can be constructed as planned. However, before final designs are completed, additional subsurface investigations will be made of each site to determine more accurately the character and extent of the materials in the foundations, abutments, emergency spillways and borrow areas. Samples will be obtained for laboratory analyses and testing.

Foundation conditions for each of the structural measures and any special problems and planned treatments are described in the following paragraphs.

Blandford Site Dam

The soil in the left abutment is a silty, gravelly, fine to coarse sand unit as much as 20 feet deep and underlain by quartz, biotite gneiss. The right abutment is of glacial till. The foundation is recent valley fill. The bedrock outcrops are moderately jointed quartz, biotite gneiss facies of the Rowe schist. Positive cutoff will be difficult to achieve and minor leakage may occur due to about 17 feet of silty sand valley fill with low to medium permeability. The borrow material, from the emergency spillway, is glacial till.

For final design, about 25 additional drill holes, test pitting, and testing of soil samples will be required.

Brooker Site Dam

The soil in the left abutment is primarily bedrock with a discontinuous thin soil cover. The right abutment is glacial till. The bedrock is slightly to moderately jointed hard quartz biotite gneiss of the Becket Gneiss. The foundation is valley fill (gravelly, silty sand) and generally is dense, but has medium permeability. Leakage may occur through the foundation. The borrow material, from the right side of the pool area is glacial till.

Before final designs are prepared, approximately 15 borings will be made, together with test pitting and testing.

Cherry Site Reservoir and Dam

The soil in the left abutment is glacial till from 0 to 18 feet thick overlying bedrock. The right abutment, primarily boulders and bedrock, has about 400 cubic yards of boulders on the ground surface. Embankment fill will be placed directly on the irregular bedrock surface on the left abutment. The bedrock surface is irregular and consists of linear ridges 10 to 40 feet high separated by discontinuous valleys with opposing gradients. The ridges, parallel to the rock schistosity and at a slight angle to the main valley trend, were probably formed by glacial scouring along selective rock horizons. The foundation consists of about 7 feet of organic sand, underlain by about 19 feet of silty, gravelly sand. The borrow material, from the emergency spillway and on the right side of the pool area, is glacial till. The borrow area may have to be enlarged to obtain sufficient borrow materials because of the irregular thickness of the till over bedrock. Minor leakage may occur through the bedrock, but it is expected that any leakage will not affect the water holding requirements of the site reservoir significantly.

Approximately 18 borings, test pitting and testing will be required for final design.

Coles Site Reservoir and Dam

The soil on the left abutment is glacial till. The right abutment is englacial drift underlain by gneissic bedrock. The foundation is recent valley fill. The bedrock is slightly jointed, and is gray, hard, quartz, biotite gneiss. A cutoff core trench will be used in the 10-foot foundation section to prevent leakage. The major borrow area, on the left side of the pool area, may have to be expanded to the northeast if depths to bedrock are constantly less than the estimated 20 feet. It is not expected that the slight amount of leakage, confined to the bedrock, will affect the water holding requirements.

Additional subsurface investigations for final design will require about 18 drill holes, test pits, and permeability and soil sample tests.

Cushman Site Reservoir and Dam

The soil on the left abutment is silty sand with gravel glacial outwash and bedrock. The right abutment is granitic bedrock with a thin soil mantle. The surface of the right abutment, the downstream portion of the valley floor and the lower portion of the left abutment is covered with boulders, amounting to 85 to 95% of surface cover. Mean diameters of boulders range from one to 16 feet. The foundation is about 18 feet of stratified, silty, fine sand with occasional boulders. The bedrock is quartz, biotite, granulite gneiss which is hard and moderately jointed. Large boulders, larger than one cubic yard, cover about 40 percent of the foundation area. Some minor leakage may occur through the outwash materials on the left abutment and through the bedrock on both abutments. This leakage is not expected to affect the water holding requirements at the site reservoir. The borrow area, from the left side of the pool area, will be stratified silty sand and gravel.

For final design, about 15 additional drill holes, test pits and permeability and soil tests will be required.

Factory Site Reservoir and Dam

The soil on the left abutment is glacial till overlying gneiss bedrock. The right abutment is gneiss bedrock with a thin veneer of colluvial soil with cobbles and boulders. The right abutment and most of the foundation area is shallow to bedrock (0 to 20 feet) or glacial till. The bedrock on the left side of the valley floor for a distance of about 270 feet is fractured Coles Brook Limestone or dolomitic marble. Bedding planes of the limestone unit strikes north 30 degrees west (about normal to the centerline of the dam) and dips about 45 degrees northeastward. Fractures dip about 60 to 70 degrees westward. The fractures cored did not show leaking. Pressure testing of the limestone at 50 psi showed a K factor of 0.10 feet per day. The balance of the foundation area is underlain by gneiss below the valley fill section. A cutoff trench, backfilled with glacial till will be installed across the entire foundation area to tie into glacial till on the left abutment and bedrock on the right abutment. The borrow area is on the left side of the pool near the left abutment and is silty, fine to coarse sand with gravel, cobbles and boulders.

Prior to final design, about 22 additional borings will be made. Also, test pits will be dug in the emergency spillway and adequate tests will be made.

Rudd Site Reservoir and Dam

The soil on both abutments have cores of glacial till capped by sand and gravel deposits 16 to 18 feet thick. The foundation is coarse recent alluvium 9 to 10 feet thick, underlain by till and bedrock. The bedrock, Becket gneiss, is tight and moderately jointed. Leakage would be confined to the permeable glacio-fluvial material on the right abutment. A cut-off trench will be used through this material. The borrow material, from the emergency spillway, will be silty sand with gravel, (glacial outwash) and glacial till.

About 15 drill holes, test pits and testing will be made before final design.

Shaker Site Reservoir and Dam

The soil in the left abutment is englacial drift or outwash sand and gravel. The right abutment is glacial till. The foundation is recent valley fill underlain by bedrock at relatively shallow depths. Bedrock crops out in the stream above the dam and is quartz biotite gneiss. The borrow material, from the emergency spillway, is englacial drift. Another borrow area, adjacent to the right abutment, is glacial till. This material will be used as backfill material in the core trench.

Additional subsurface investigations will consist of about 15 drill holes, test pits and testing.

Upper Coles Site Reservoir and Dam

The soil in the left abutment is englacial drift overlying bedrock. The right abutment is silty gravelly sand overlying gneiss bedrock. The foundation material is recent alluvium. The Becket Gneiss Bedrock is moderately jointed and a slight amount of leakage is expected in the bedrock on the right abutment. The emergency spillway will be in the gneissic bedrock on the left abutment. The borrow, from the left side of the pool area, will be glacial till.

For final design, about 16 drill holes, test pitting and testing will be required.

Upper Factory Site Reservoir and Dam

The soil in the left abutment is gneissic bedrock with a 0 to 10 foot cover of silty gravel or sand. The right abutment is englacial drift with some glacio-fluvial sand and gravel near the valley floor. The foundation is recent valley fill overlying bedrock. Other foundation excavation will be

fairly shallow with a positive cutoff in the glacial till. The bedrock is moderately jointed, with the possibility of a fault between the left abutment and center of the valley floor. There is also a possibility of dolomitic limestone on the right abutment. The borrow from the emergency spillway and right side of the pool area, will be nonplastic englacial drift.

About 18 drill holes, 14 test pits and testing of samples will be required for final design.

Walker Site Reservoir and Dam

The soil in the left abutment is glacio-fluvial sand and gravel overlaying glacial till. The right abutment and foundation is sand and gravel underlain by glacial till. The bedrock outcrops in the stream below the dam is somewhat fractured quartz, biotite gneiss. In the foundation area, no bedrock was encountered to a depth of 60 feet. About the first ten feet of the emergency spillway will be glacio-fluvial sand and gravel which can be used for fill material for the Route 20 road relocation or to blanket the dam. The underlying glacial till in the emergency spillway and the borrow area upstream of the dam in the pool area will be used for the embankment fill.

For final design, about 15 additional drill holes, test pits and testing will be required.

Channel Improvements

In the reach of the channel improvements at Huntington, the West Branch of the Westfield River is entrenched in the older terrace sand and gravel of the flood plain. Erosion and scouring of the river channel is controlled by armor plating in the stream and frequent exposures of bedrock.

In channel improvement area at Chester, the stream is confined by either bedrock along both banks or by bedrock with a thin mantle of sand and gravel. Prior to final design a detailed geologic investigation will be made to determine the extent of bedrock and other channel conditions at each area of planned improvement.

ENGINEERING

Twenty-five potential storage sites were identified and located on USGS Quadrangle Maps by a map study and field reconnaissance. Preliminary

designs and cost estimates were prepared for each site, using data developed from the 7 1/2 minute USGS topographic maps. Thirteen sites were selected for further consideration based upon the preliminary cost estimates and the relative effectiveness of the structures in solving watershed problems and meeting project objectives.

A detailed topographic map, covering the reservoir, dam and emergency spillway, was prepared for each of the thirteen sites. The topographic maps on ten sites were made from a special flight of aerial photographic by stereoplotter and checked by field surveys for accuracy. Three topographic maps were made by plane table surveys. All elevations were referenced to mean sea level.

The Sponsors, with the assistance of Federal and State agencies, determined the multipurpose uses to be included in each site. Based upon the detailed topographic maps and stage-capacity curves, the Sponsors selected capacities, surface areas and pool elevations for each multipurpose use to be incorporated.

Following completion of the hydrologic investigations, selection of other purposes to be included in each site, and determination of relative effectiveness of each structure on reduction of flood damages, eleven sites were selected for inclusion in the plan. For the streams where two structures are in series, a comparison was made of the alternatives: One single-purpose floodwater retarding structure; one multi-purpose structure; two multipurpose structures; and one single-purpose structure and one multipurpose structure. Consideration was given to the site topographic limits, total installation costs, allocated costs to purposes, drainage area controlled and water resource development needs. The structures selected were found to be the most feasible to meet the project objectives.

Work plan designs for structural measures were developed using the detailed topographic maps, results of geologic investigations on each site and standard design procedures outlined in the Soil Conservation Service's Technical Releases and National Engineering Handbooks. Cost estimates were completed using latest construction cost information from similar construction projects in the Northeast. These work plan designs were then reviewed with the Sponsors, Soil Conservation Service Design Section and participating State agencies.

A photomosaiac map of the entire watershed was prepared and proposed sites located on the map. The Sponsors, with the assistance of the Service, located approximate property lines with apparent land ownership on the photomosaiac map. The apparent land ownership was then transferred to individual site maps showing site and reservoir features, property lines and land ownership. These maps will be furnished the Sponsors as soon as the plan is completed, reviewed and approved by the Sponsors and State and local agencies.

Descriptions and installation details for each structure are listed under "Works of Improvement to be Installed." Preliminary plans are shown on Figures 1 through 13. Structure and design data are shown on Table 3.

Multipurpose Structures

Beneficial storage capacities and surface areas for the fish and wildlife water resource improvement were furnished by the Sponsors, with assistance from the Massachusetts Division of Fisheries and Game. The beneficial water storage and surface area for the Factory Recreation Development was furnished by the Sponsors, with assistance from the Massachusetts Division of Forests and Parks. Specific volumes for wildlife pools and low-flow augmentation and specific areas for fish pools and recreation pools were assigned to selected sites. Work plan designs and cost estimates were based on the selection made by the Sponsors for each multi-purpose site.

Each multi-purpose structure is designed with a principal spillway crest elevation at the maximum beneficial pool elevation. Each principal spillway consists of a reinforced concrete riser, outlet pipe conduit and reinforced concrete stilling basin. An additional feature of the riser will be an adjustable cold water release device. The preliminary design provides for cold water release by a concrete box, as an appurtenance to the principal spillway riser, enclosing the orifice and going from the bottom of the riser to just above the permanent pool. Normal stream flows will then be drawn from the bottom of the pool and forced over the crest of the principal spillway inside the concrete box. For those sites where low-flow augmentation water storage is included, an adjustable gate, near the bottom of the pool, will control the release rate of the low-flow augmentation waters. Alternate methods for releasing cold waters and low-flow augmentation will be evaluated during final design and the most feasible method, consistent with project objectives, will be selected. The risers will also be equipped with an anti-vortex device and pond drain.

Recreation Facilities

The recreation facilities at the Factory Recreation Development were planned by recreation specialists from the Division of Forests and Parks. Following a field reconnaissance of the land around the permanent pool and using USGS topographic maps, site topographic maps, aerial photographs and soil capability maps, a preliminary plan was prepared. The preliminary plan located the use areas, possible road locations, and major facilities. The number of each facility was based upon current demands and applicable state and local health laws. Provisions were included for future expansion of all facilities. Estimated costs were based on current costs for comparable facilities at other State Parks in Massachusetts.

The Massachusetts Department of Natural Resources will prepare final designs and plans and specifications for the recreation facilities. A detailed topographic map of the area around the permanent pool will be developed prior to completing the construction plans. Due to the limited site information available and preliminary nature of the recreation development plans, the location of the recreation facilities could be changed during final design.

Geologic investigations will be made of the recreation development to locate a suitable water supply and drainage fields for sewage disposal. In the event that no areas are found suitable for sewerage drainage fields, a treatment plant will be installed. The Service will review and approve all final plans and designs prepared by others prior to construction of any cost-shared recreation facilities.

The Sponsors and other participating agencies have reviewed the preliminary plans, together with cost, cost-sharing, operation, maintenance, and replacement responsibilities.

Single-Purpose Structures

The two single-purpose floodwater retarding structures were considered for multipurpose use, but were found not practical due to site conditions. Temporary storage is provided to accommodate the 100-year frequency flood runoff. The principal spillways will be ported near the streambed elevation to allow normal stream flows to pass through the structure and there will be no water impounded behind the dams. Each principal spillway consists of a reinforced concrete riser, outlet conduit and reinforced concrete stilling basin.

Channel Improvements

Channel improvements included in this plan were selected after a careful study of the local areas to be protected. A comparison was made between diking, diking and channel improvement and channel improvement only. Channel improvements were selected because of site conditions, restricted construction areas and reductions in operation and maintenance costs.

Expanded water surface profiles were prepared covering the two sections of channel improvement. Both profiles indicated that flow velocities will be altered by the bridge restrictions during periods of high flow.

Because of design velocities, approximately 1700 feet of streambank will be protected. At station 114+88 of the Huntington channel, flow is presently controlled by a rock outcrop which will be excavated to provide the design capacity.

Costs

Preliminary designs and cost estimates were prepared for alternative structural measures. The most economical designs and measures were selected which most nearly met the project objectives. Quantities of construction material were computed for the structures selected. Estimated costs were based upon construction quantities and unit costs. Unit costs were taken from bid item schedules for work recently completed in the vicinity, modified by differences in site conditions. These differences include location, topography, geologic characteristics, size of construction bid items, and availability and accessibility of materials.

Designs and cost estimates for the works of improvement were reviewed by the Sponsors, with assistance from the Massachusetts Water Resources Commission.

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Chap. 634. AN ACT AUTHORIZING THE WATER RESOURCES COMMISSION TO CONSTRUCT RESERVOIRS AND OTHER WORKS OF IMPROVEMENT FOR FLOOD PREVENTION, LOW FLOW REGULATION, RECREATION, AND RELATED PURPOSES IN THE WATERSHED OF THE WEST BRANCH OF THE WESTFIELD RIVER.

Be it enacted, etc., as follows:

SECTION 1. The water resources commission is hereby authorized to enter into watershed work plan agreements and project agreements with the United States department of agriculture for the construction of certain works of improvement including water retention structures in the

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watershed area of the West Branch of the Westfield River in the counties of Berkshire, Hampden and Hampshire for the purpose of flood prevention, low flow regulation, recreation, and related purposes, including water storage, stream bank stabilization, channel modification and water resource utilization, in accordance with the Watershed Protection and Flood Prevention Act, and with a watershed work plan. Said agreements shall set forth the federal share of the cost of construction of the works of improvement allocated to flood control or other flood retardation works, and such other sums as the federal government is to pay on account of other works to be included in the overall project and authorized by said act.

SECTION 2. When said commission and the department of agriculture have entered into a project agreement for works of improvement authorized by section one, the commission shall be the contracting authority for the construction of such works.

Said commission, acting for and in behalf of the commonwealth, may acquire by gift, purchase, or otherwise, any land, water rights, rights-of-way or other easements, public or private, necessary to carry out the purposes of this act. Public access shall be provided to any reservoir area constructed under this act. Said commission may, with the approval of the department of natural resources, utilize the land under the control of said department for such works. Upon the occurrence of unforeseen conditions or excessive costs from land takings or otherwise at any of the sites designated in said work plan, the commission may, with the approval of the department of agriculture, relocate any reservoir site or other works contemplated by said work plan to another site within the watershed area referred to in section one, in order to carry out the purposes of this act more effectively and economically. The commission may, in its discretion and when it appears to be necessary, advantageous, or in the best interest of the commonwealth, in lieu of the taking or acquisition of land, expend out of the funds appropriated under section five for expenditure by the commission such sums as may be required to carry out or expedite the purposes of this act for the construction of works not included in the costs reimbursable by the federal government under said watershed protection and flood prevention act, and determined by the commission to be necessary to carry out the commonwealth's share of the project, including but not limited to the construction of dikes or other water retardation works, changes in private property grades, highway locations and grades, the location or relocation of culverts, water and sewer pipes, utility poles and lines, conduits or other fixtures, pipe lines, wells, septic tanks, cesspools or similar works, whether privately or publicly owned. The commission shall operate, maintain and administer all such lands, waters and works of improvement or it may transfer the same to the department.

SECTION 3. The commission and the division of water resources, through their duly authorized agents, without being liable for trespass, shall have the right to enter upon any lands for the purpose of making surveys, test pits and borings, and the commission may take or otherwise acquire the right temporarily to occupy lands necessary for the construction of any works or for any other purposes authorized by this act.

SECTION 4. The department of natural resources, acting for and in behalf of the commonwealth, may acquire by gift, purchase, eminent domain or otherwise, land, water rights, rights-of-way or other ease-

ments, public or private, appropriate for public outdoor recreation in conjunction with the lands acquired and the works constructed by the commission under this act and may accept transfers of land and works from the commission. The department of natural resources under the provisions of chapter one hundred and thirty-two A of the General Laws shall plan, develop, improve and construct recreation facilities upon, operate, administer and maintain such lands, waters and facilities. The commission shall advise the department on the operation of all water retention structures. The cost of the operation, administration and maintenance of such lands, waters, works and facilities shall be charged to the State Recreation Areas Fund established under chapter one hundred and thirty-two A of the General Laws. The department may apply for and accept any federal funds available for assistance for the purposes of this section.

SECTION 5. The commission is hereby authorized and directed to expend a sum not to exceed three million nine hundred seventy thousand dollars for the acquisition of lands and waters and the construction of works of improvement and related costs authorized by sections one and two of this act, provided, however, that the commonwealth's non-reimbursable share of the cost of said acquisition and construction shall not exceed one million three hundred thousand dollars.

The department of natural resources is hereby authorized and directed to expend a sum not exceeding one million seven hundred thousand dollars for the acquisition, planning, development and improvement of outdoor recreation areas and facilities authorized by section four of this act.

SECTION 6. To provide funds for payment of the commonwealth's share of the cost of the project authorized in sections one and two, the state treasurer shall, upon request of the governor, issue and sell at public or private sale bonds of the commonwealth, registered or with interest coupons attached, as he may deem best, to an amount to be specified by the governor from time to time, but not exceeding, in the aggregate, the sum of one million three hundred thousand dollars. All bonds issued by the commonwealth, as aforesaid, shall be designated on their face, Westfield River West Branch Watershed Improvement Project Loan, Act of 1968, and shall be on the serial payment plan for such maximum term of years not exceeding ten years, as the governor may recommend to the general court pursuant to Section 3 of Article LXII of the Amendments to the Constitution of the Commonwealth, the maturities thereof to be so arranged that the amounts payable in the several years of the period of amortization other than the final year shall be as nearly equal as in the opinion of the state treasurer it is practicable to make them. Said bonds shall bear interest semiannually at such rate as the state treasurer, with the approval of the governor, shall fix. The initial maturities of such bonds shall be payable not later than one year from the date of issuance thereof and the entire issue not later than June thirtieth, nineteen hundred and eighty-three.

SECTION 7. To provide funds for payment of the federal share of the cost of the project authorized in section one, in anticipation of the sums to be received from the federal government under section one of this act, there is hereby appropriated the sum of two million six hundred seventy thousand dollars from the Federal Capital Improvement Fund established by section two B of chapter twenty-nine of the General Laws and said appropriation shall expire on June thirtieth, nineteen

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hundred and seventy-one. Sums appropriated under this section shall be expended by the commission for purposes authorized by sections one and two of this act.

For the purpose of meeting payments authorized by this section in anticipation of the receipt of federal funds, the state treasurer may borrow from time to time, on the credit of the commonwealth, such sums as may be necessary and may issue and renew, from time to time, notes of the commonwealth therefor, bearing interest payable at such times and at such rates as shall be fixed by the state treasurer. Such notes shall be issued and may be renewed one or more times for such terms, not exceeding one year, as the governor may recommend to the general court in accordance with Section 3 of Article LXII of the Amendments to the Constitution of the Commonwealth, but the final maturities of such notes, whether original or renewal, shall not be later than June thirtieth, nineteen hundred and seventy-four. Notwithstanding any provisions of this act, such notes shall be general obligations of the commonwealth. Notwithstanding the amount appropriated, sums authorized to be borrowed in this section shall not exceed the amounts certified by the proper federal authorities as the federal share of the cost of such projects and provided further that amounts received from the federal government shall be deposited in the Federal Capital Improvement Fund and shall be available to repay any note or notes issued as provided in this section; and provided, further, that all payments on account of interest shall be allocated by the state treasurer to the fund financing the loan account for the commonwealth's share of the projects authorized by section one of this act.

SECTION 8. To meet the expenditures necessary in carrying out the responsibilities of the department of natural resources under section four of this act, other than costs of operation, administration and maintenance, the department may expend such sums as may be required for projects authorized by this section from any funds available for the development of recreation facilities within the commonwealth.

SECTION 9. Funds provided in this act shall not be subject to the provisions of section thirty A of chapter seven of the General Laws, provided that no expenditure shall be made for consultant services, so called, or services coded in accordance with the expenditure code manual under the subsidiary title "03 Services — Non-employees" unless the rate of compensation for such services shall have been approved by the commissioner of administration. Said commissioner shall, immediately upon the approval of any such rate or rates, file copies of the schedule or schedules of approved rates with the comptroller and with the house and senate committees on ways and means. Before engaging such consultant services under said subsidiary title "03", as so coded, as "Professional", the respective departments shall certify to the budget director that funds are available for the purpose and shall then file a statement of intent with the budget director, the comptroller and the house and senate committees on ways and means. Such statement shall include the rate of compensation, the period of time for which the services are to be engaged or scope of work to be done, and such other pertinent information as may be necessary to establish the maximum limit of the commonwealth's obligation.

SECTION 10. Costs of the operation and maintenance of fish and wildlife management programs conducted by the division of fisheries and

game of the department of natural resources, with the approval of the department or commission administering the land or water on which said programs are to be conducted, shall be charged against the Inland Fisheries and Game Fund. *Approved July 16, 1968.*

The Commonwealth of Massachusetts
Advance copy 1969 Acts and Resolves
JOHN F. X. DAVOREN, *Secretary of the Commonwealth*

Chap. 674. AN ACT MAKING CERTAIN CORRECTIVE CHANGES IN THE LAW RELATIVE TO THE WESTFIELD RIVER WEST BRANCH WATERSHED IMPROVEMENT PROJECT AND AUTHORIZING THE DEPARTMENT OF NATURAL RESOURCES TO RECEIVE FEDERAL FINANCIAL ASSISTANCE IN CONNECTION THEREWITH.

Be it enacted, etc., as follows:

SECTION 1. The second paragraph of section 2 of chapter 634 of the acts of 1968 is hereby amended by striking out the first sentence and inserting in place thereof the following sentence:— Said commission, acting for and in behalf of the commonwealth, may acquire by gift, purchase, eminent domain or otherwise any land, water rights, rights-of-way or other easements, public or private, necessary to carry out the purposes of this act.

Section 2. Section 5 of said chapter 634 is hereby amended by striking out the first paragraph and inserting in place thereof the following paragraph: —

The water resources commission is hereby authorized to expend the sum of one million, three hundred thousand dollars for the acquisition of lands and waters, the construction of works of improvement, and related costs, authorized by sections one and two of this act.

Section 3. Section 6 of said chapter 634 is hereby amended by striking out, in lines 1 and 2, the word "commonwealth's" and inserting in place thereof the words: — water resources commission's.

Section 4. Section 7 of said chapter 634 is hereby amended by striking out the first paragraph and inserting in place thereof the following two paragraphs: —

The water resources commission and the department of natural resources or either of them may enter into agreements with the United States Department of Agriculture or other agency of the federal government for the receipt of funds to a total amount not to exceed two million, six hundred and seventy thousand dollars for the purposes authorized by this act.

To provide funds for payment of the federal share of the cost of the projects authorized by this act and for meeting federal allocations in anticipation of the sums to be received from the federal government under this act, there is hereby appropriated the sum of two million, six hundred and seventy thousand dollars from the federal Capital Improvement Fund established by section two B of chapter twenty-nine of the General Laws and said appropriation shall expire on June thirtieth, nineteen hundred and seventy-one. Sums appropriated under this section shall be expended by the department or the commission, in accordance with said agreements, for the purposes authorized by this act and shall be in addition to appropriations and authorizations contained elsewhere in this act.

Section 5. The second paragraph of said section 7 of said chapter 634 is hereby amended by striking out, in lines 22 and 23, the words "fund financing the loan account for the commonwealth's share of the projects authorized by section one of this act" and inserting in place thereof the words: — funds financing the loan accounts providing funds for expenditures authorized by sections five and eight of this act in proportion to which the federal funds received hereunder shall have been granted to the water resources commission or the department of natural resources, respectively.

Approved August 11, 1969.

APPENDIX "B"

AGREEMENT

Between the

Berkshire Conservation District
Local Organization

Hampshire Conservation District
Local Organization

Hampden Conservation District
Local Organization

Massachusetts Department of Natural Resources
Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

and the

Massachusetts Water Resources Commission
(hereinafter referred to as the Commission)

and the

Massachusetts Division of Fisheries and Game

WITH RESPECT TO INSTALLATION OF WORKS
OF IMPROVEMENT IN THE WEST BRANCH
OF THE WESTFIELD RIVER WATERSHED PROJECT

WHEREAS, under the provisions of Chapter 634 of the Acts of 1968, as amended, the Commission is authorized to construct reservoirs and other works of improvement for flood prevention, low flow regulation, recreation and related purposes in the watershed of the West Branch of the Westfield River.

NOW THEREFORE, the Sponsoring Local Organization, the Commission, and the Division of Fisheries and Game.do hereby agree:

I. That the Commission, consistent with authorities and funding authorized under Chapter 634 of the Acts of 1968, as amended; and as necessary to meet the objectives included in the watershed work plan, will assume the following responsibilities of the Sponsoring Local Organization as assigned in the watershed work plan Agreement:

A. The Commission, will enter into project agreements with the United States Department of Agriculture for the construction of certain works of improvement in the watershed area of the West Branch of the Westfield River for the purpose of flood prevention, low flow regulation, recreation and related purposes, including water storage, stream bank stabilization, channel modification and water resource utilization in accordance with the Watershed Protection and Flood Prevention Act, and with a watershed work plan.

B. The Commission shall be the contracting authority for the construction of works of improvement.

C. The Commission will acquire any land, water rights, rights-of-way or other easements, public or private, necessary to carry out the purposes of Chapter 634, as amended, and the watershed work plan.

D. The Commission shall expend funds for the acquisition of lands and water and the construction of works of improvement and related costs as authorized by Sections One and Two of Chapter 634, as amended.

II. That the Massachusetts Division of Fisheries and Game will:

A. Develop the fish and wildlife potential of the areas of land obtained for project purposes.

B. Install access roads and parking areas at the eight multipurpose fish and wildlife reservoirs.

C. Install sanitary facilities at the Cherry, Upper Factory and Walker Multipurpose fish and wildlife reservoirs.

III. It is mutually agreed that:

A. The Commission shall operate, maintain and administer all such lands, waters and works of improvement acquired or constructed or it may transfer the same to the Department of Natural Resources or the Division of Fisheries and Game.

B. The Department of Natural Resources will acquire land, water rights, rights-of-way or other easements, public or private, appropriate for public outdoor recreation in conjunction with the lands acquired and the works constructed by the Commission and may accept transfers of land and works from the Commission.

C. The Department of Natural Resources will expend funds for the acquisition, planning, development and improvement of outdoor recreation areas and facilities authorized by Section 4 of Chapter 634, as amended.

D. This agreement shall become effective upon the date of approval of the West Branch of the Westfield River Watershed Work Plan by the Federal Government.

BERKSHIRE CONSERVATION DISTRICT
Local Organization

By _____

Title Chairman

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Berkshire Conservation District adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date _____

****

HAMPDEN CONSERVATION DISTRICT
Local Organization

By _____

Title Chairman

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Hampden Conservation District adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date _____

MASSACHUSETTS WATER RESOURCES COMMISSION

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the Massachusetts Water Resource Commission adopted at a meeting held on _____.

_____
Secretary

Date _____

****

MASSACHUSETTS DIVISION OF FISHERIES AND GAME

By _____

Title _____ Director _____

Date _____

HAMPSHIRE CONSERVATION DISTRICT
Local Organization

By _____

Title Chairman

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the Hampshire Conservation District adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date _____

****

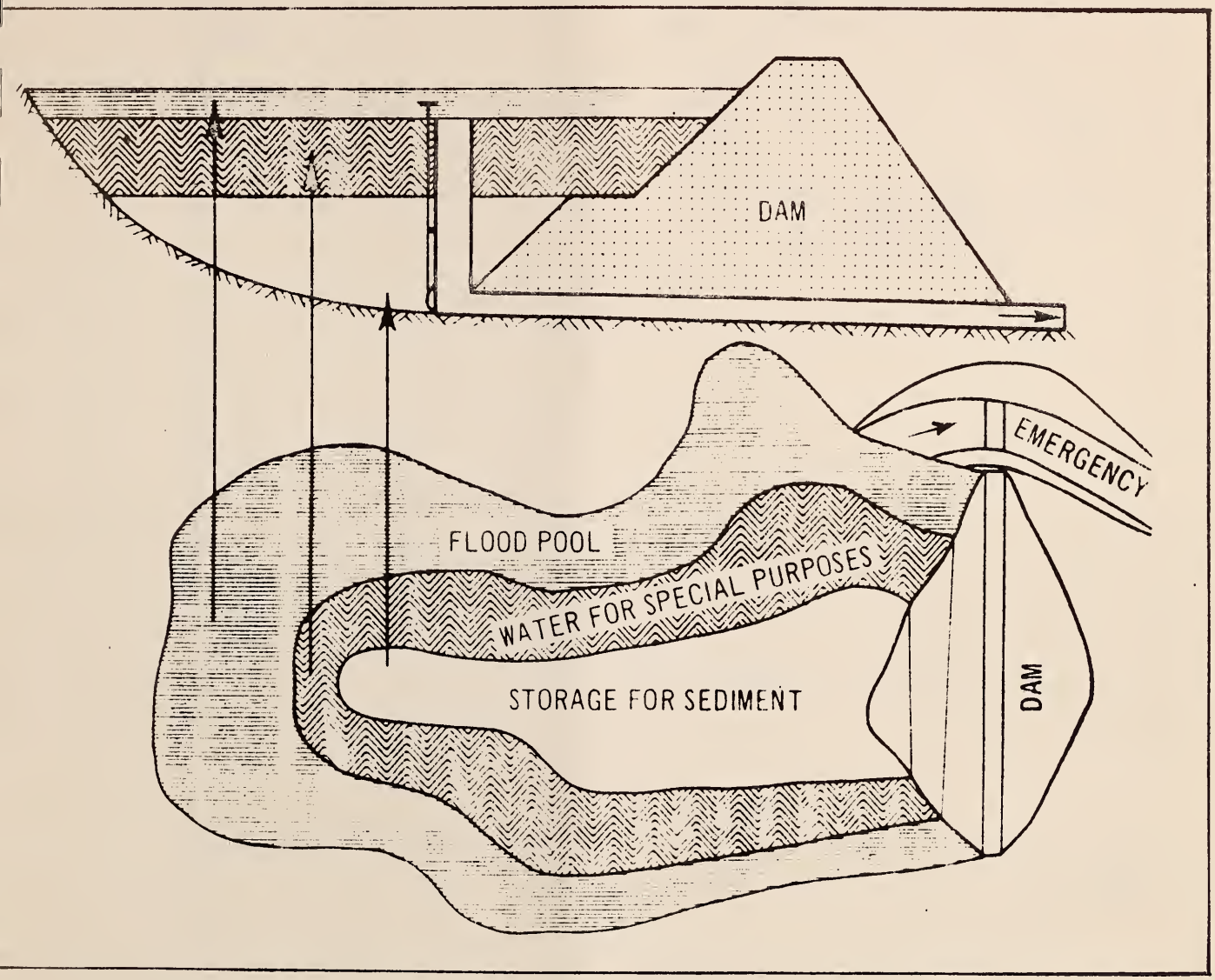
MASSACHUSETTS DEPARTMENT OF NATURAL RESOURCES
(Local Organization)

By _____

Title Commissioner

Date _____

TYPICAL MULTI-PURPOSE DETENTION RESERVOIR



Cross-sectional and plan views of detention reservoir Water for special purposes is stored between flood pool (above) and sediment storage (bottom pool) These purposes could include one or more of the following · Low-flow augmentation, recreation, fish and wildlife.

Fig. 0

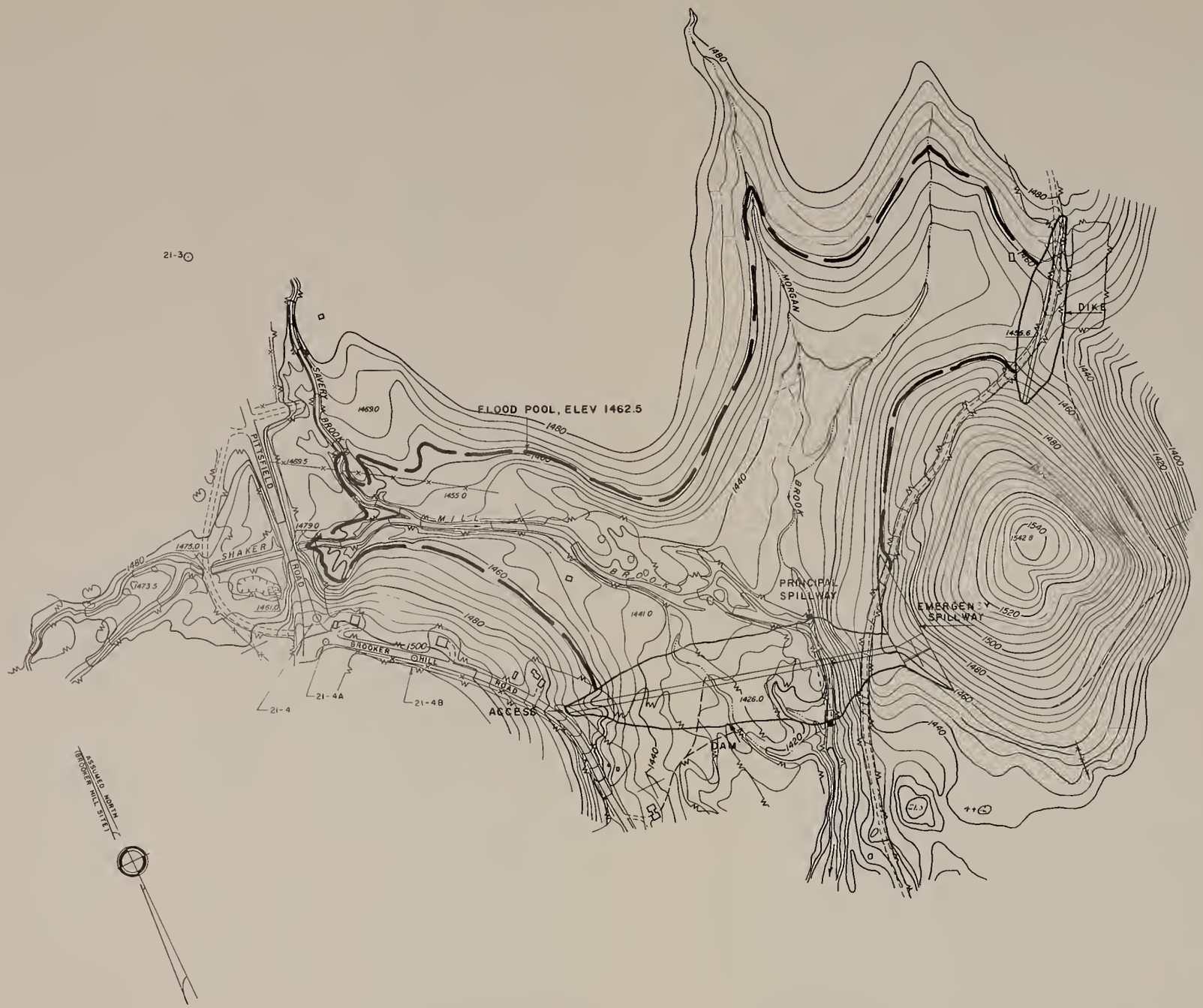
Horizontal Control By New England Survey Service Inc.
Vertical Control By U.S.G.S. & New England Survey Service Inc
Compilation By Fairchild Surveys Inc From Photography Of May 5, 1955

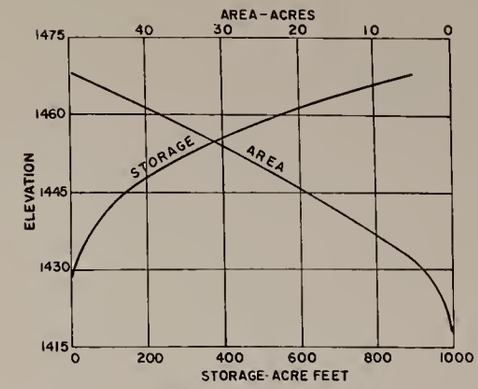
Figure 1
Preliminary Plans

BLANDFORD SITE

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE





AREA - CAPACITY CURVES

Horizontal Control By New England Survey Service Inc.
Vertical Control By U.S.G.S. & New England Survey Service Inc.
Compilation By Fairchild Surveys Inc. From Photography Of May 5, 1965

200 0 200 400 600 Feet

GRID COORDINATE SYSTEM ASSUMED

Figure 2
Preliminary Plans

BROOKER SITE

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

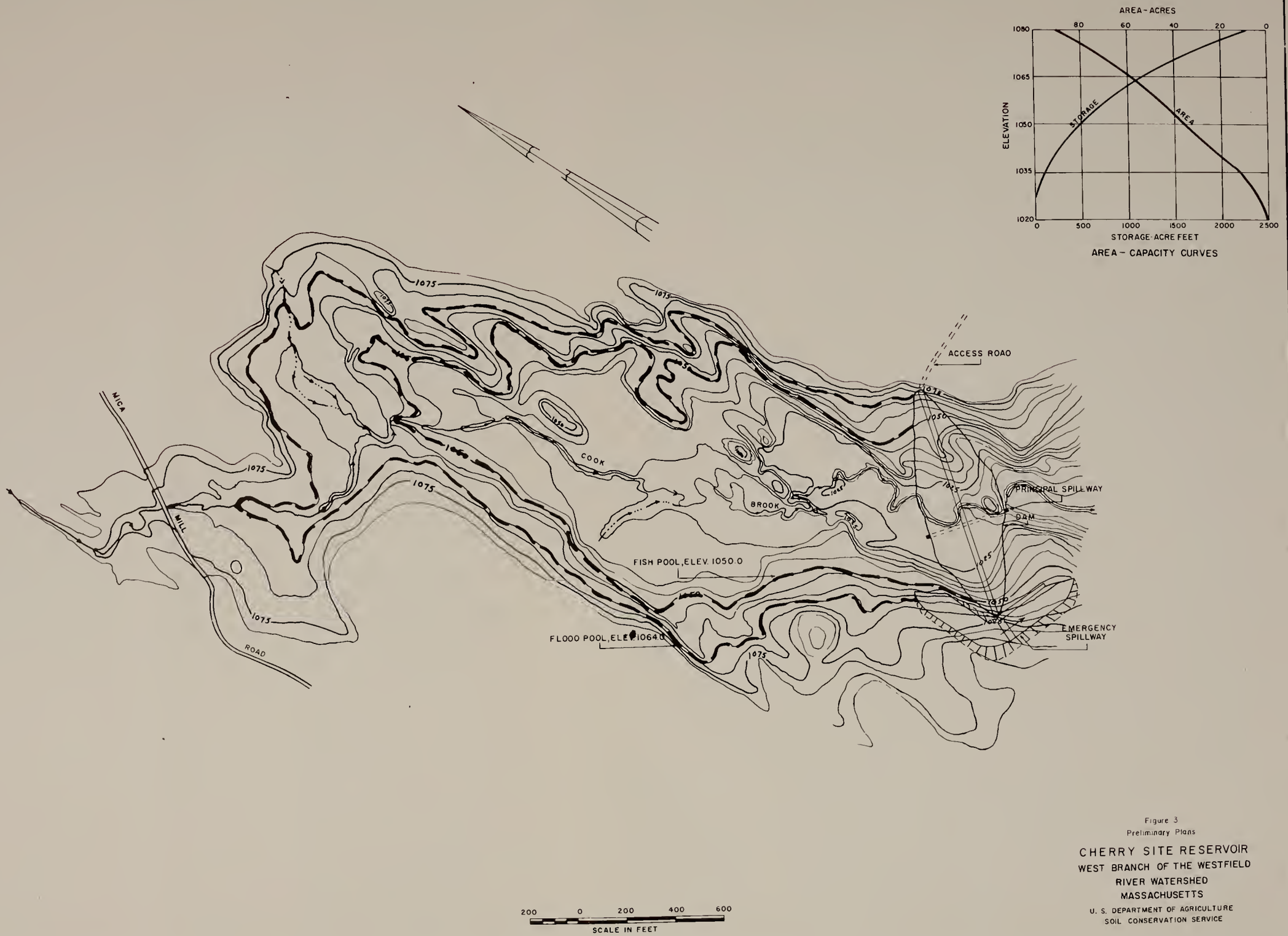
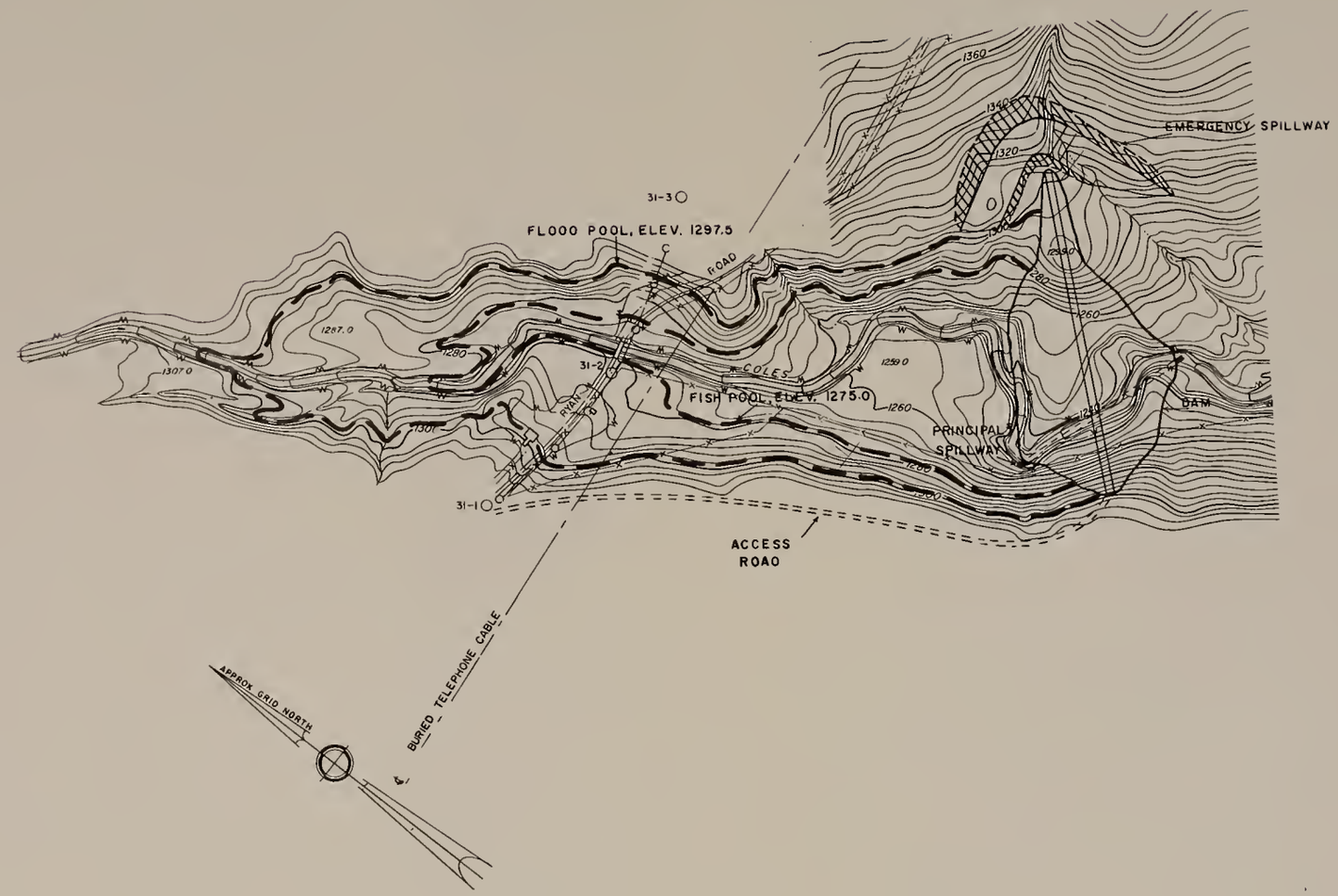
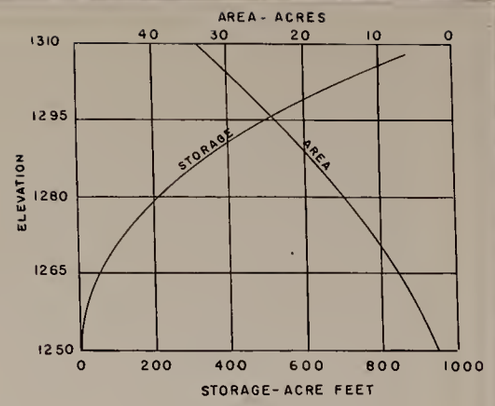


Figure 3
Preliminary Plans

CHERRY SITE RESERVOIR
WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE





AREA - CAPACITY CURVES

E 180,000 N 495,000 E 181,000 N 494,000 N 493,000 E 182,000 E 179,000 N 494,000 E 178,000 E 182,000 N 490,000 N 489,000 E 180,000 E 177,000 N 493,000 N 492,000 E 178,000 N 491,000 E 179,000

Horizontal Control By New England Survey Service Inc
Vertical Control By U S G S & New England Survey Service Inc.
Compilation By Fairchild Surveys Inc From Photography Of May 5, 1965

200 0 200 400 600 Feet

GRID COORDINATE SYSTEM ASSUMED

Figure 4
Preliminary Plans

COLES SITE RESERVOIR
WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Horizontal Control By New England Survey Service Inc.
Vertical Control By U S G S & New England Survey Service Inc.
Compilation By Fairchild Aerial Surveys Inc From Photography Of May 5, 1965.

Figure 5
Preliminary Plans

CUSHMAN SITE RESERVOIR

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FLOOD POOL ELEV. 1377.5
RECREATION POOL, ELEV. 1370.0
BROOK

Figure 7
Preliminary Plans

RUDD SITE RESERVOIR

WEST BRANCH OF THE WESTFIELD
RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

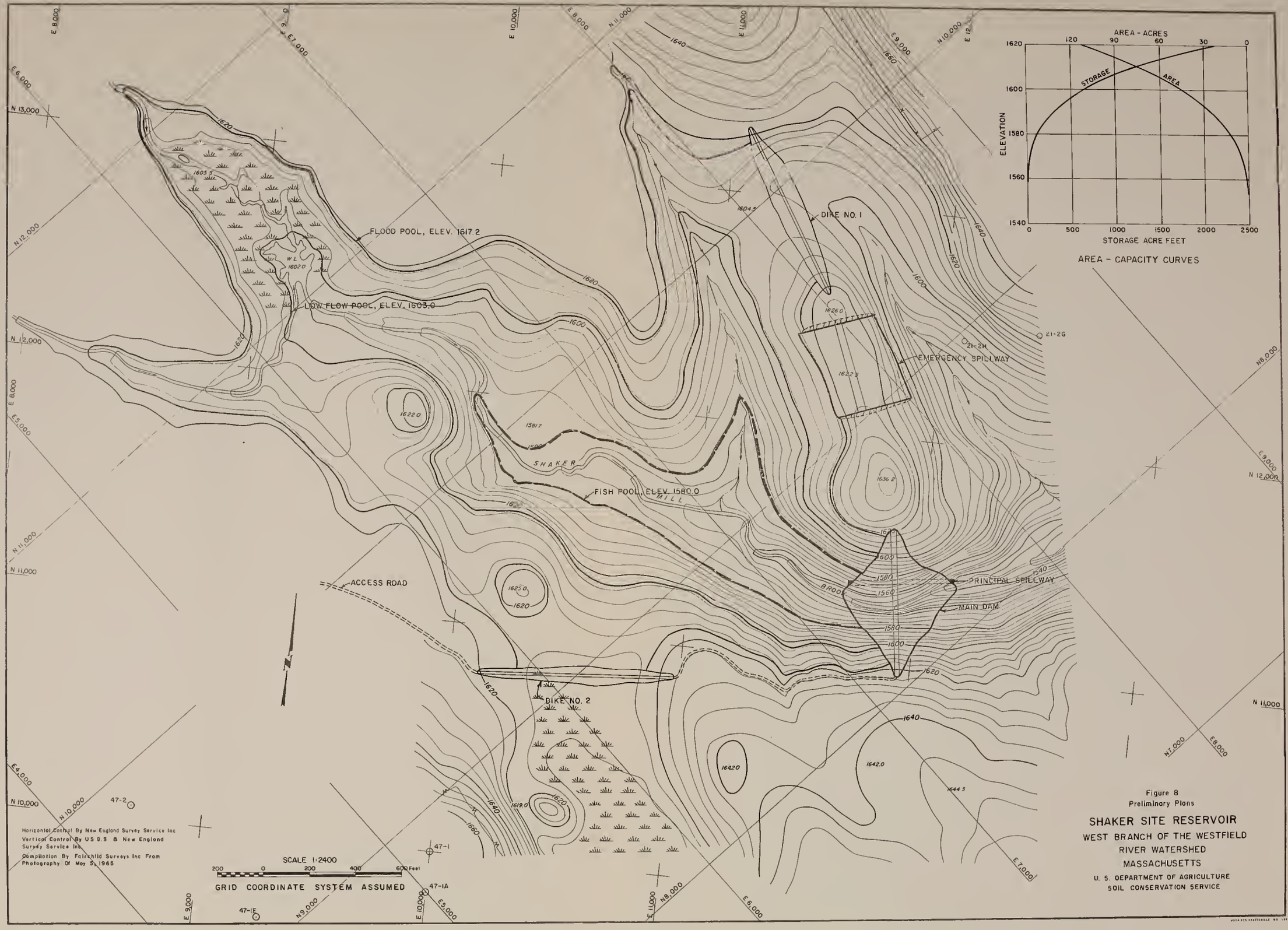


Figure 8
Preliminary Plans

SHAKER SITE RESERVOIR

WEST BRANCH OF THE WESTFIELD
RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Horizontal Control By New England Survey Service Inc.
Vertical Control By U.S.G.S. & New England Survey Service Inc.
Compilation By Fairchild Surveys Inc From Photography Of May 5, 1965

300 0 300 600 900 Feet

GRID COORDINATE SYSTEM ASSUMED

Figure 9
Preliminary Plans

UPPER COLES SITE RESERVOIR
WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

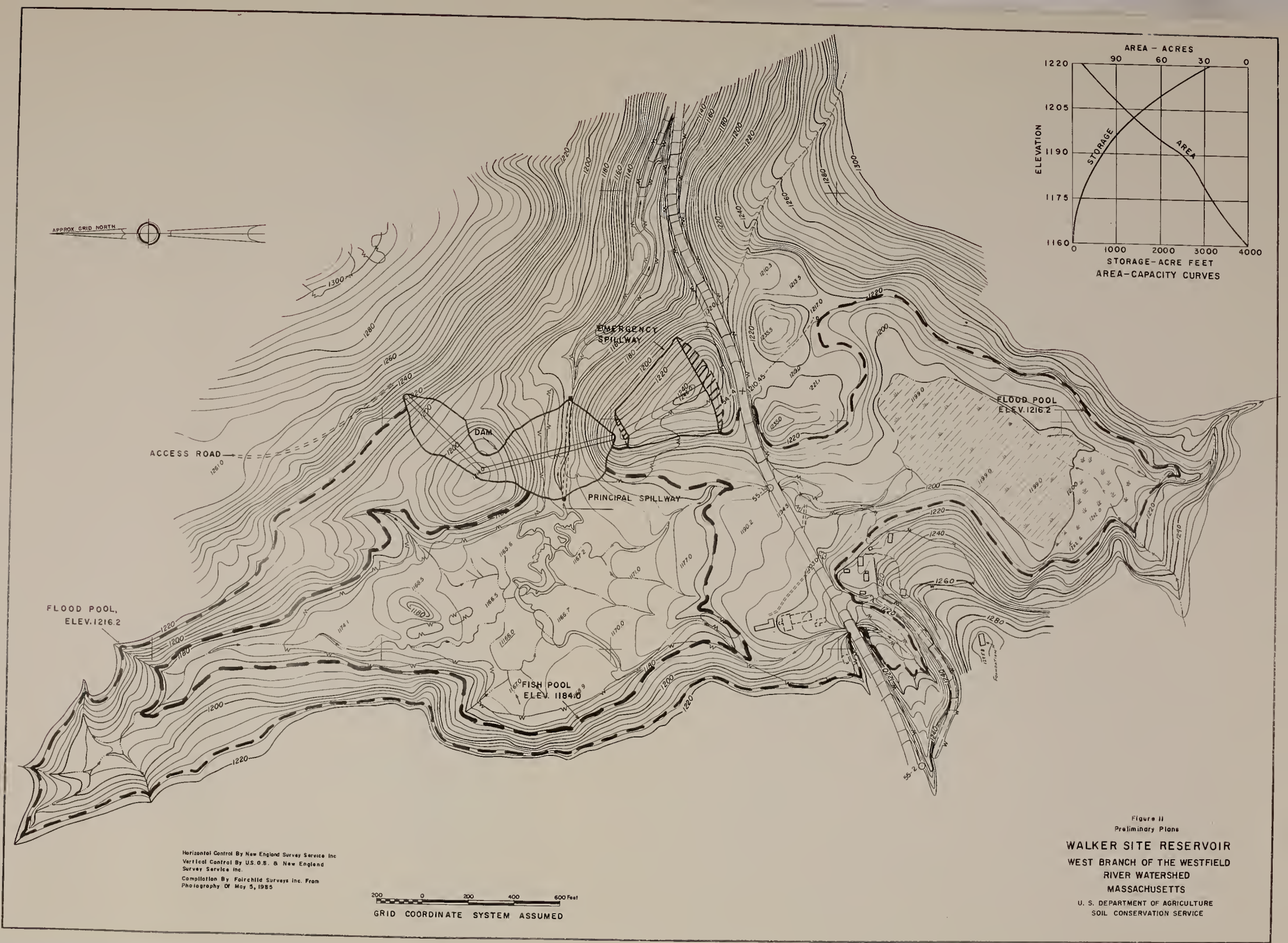
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Figure 10
Preliminary Plans

UPPER FACTORY SITE RESERVOIR

WEST BRANCH OF THE WESTFIELD
RIVER WATERSHED
MASSACHUSETTS

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



Horizontal Control By New England Survey Service Inc
Vertical Control By U.S.G.S. & New England Survey Service Inc.
Compilation By Fairchild Surveys Inc. From Photography Of May 5, 1955

Figure 11
Preliminary Plans

WALKER SITE RESERVOIR

WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

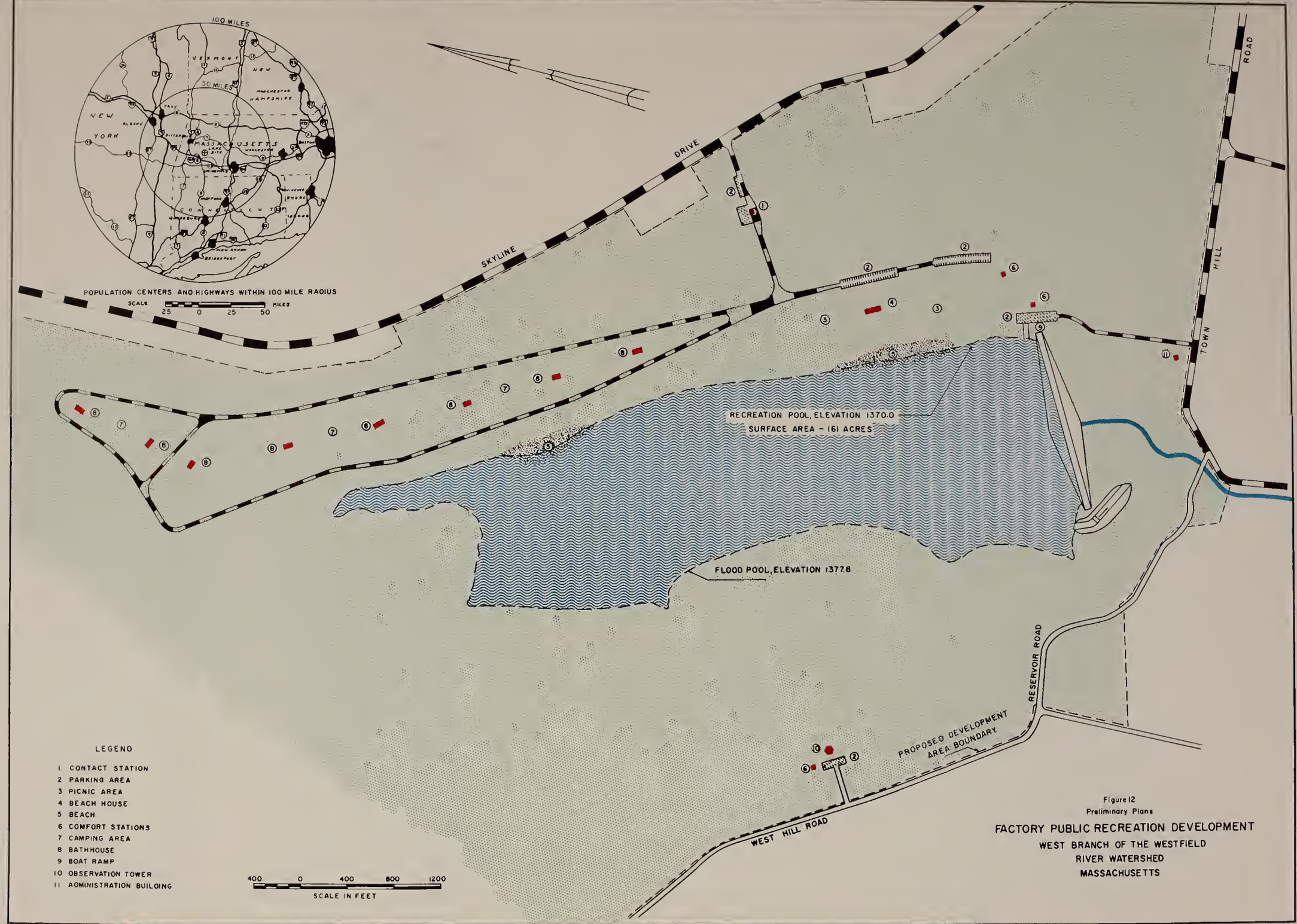


Figure 12
Preliminary Plans

FACTORY PUBLIC RECREATION DEVELOPMENT

WEST BRANCH OF THE WESTFIELD
RIVER WATERSHED
MASSACHUSETTS

USDA-SCS-HYATTSVILLE, MD. 1969

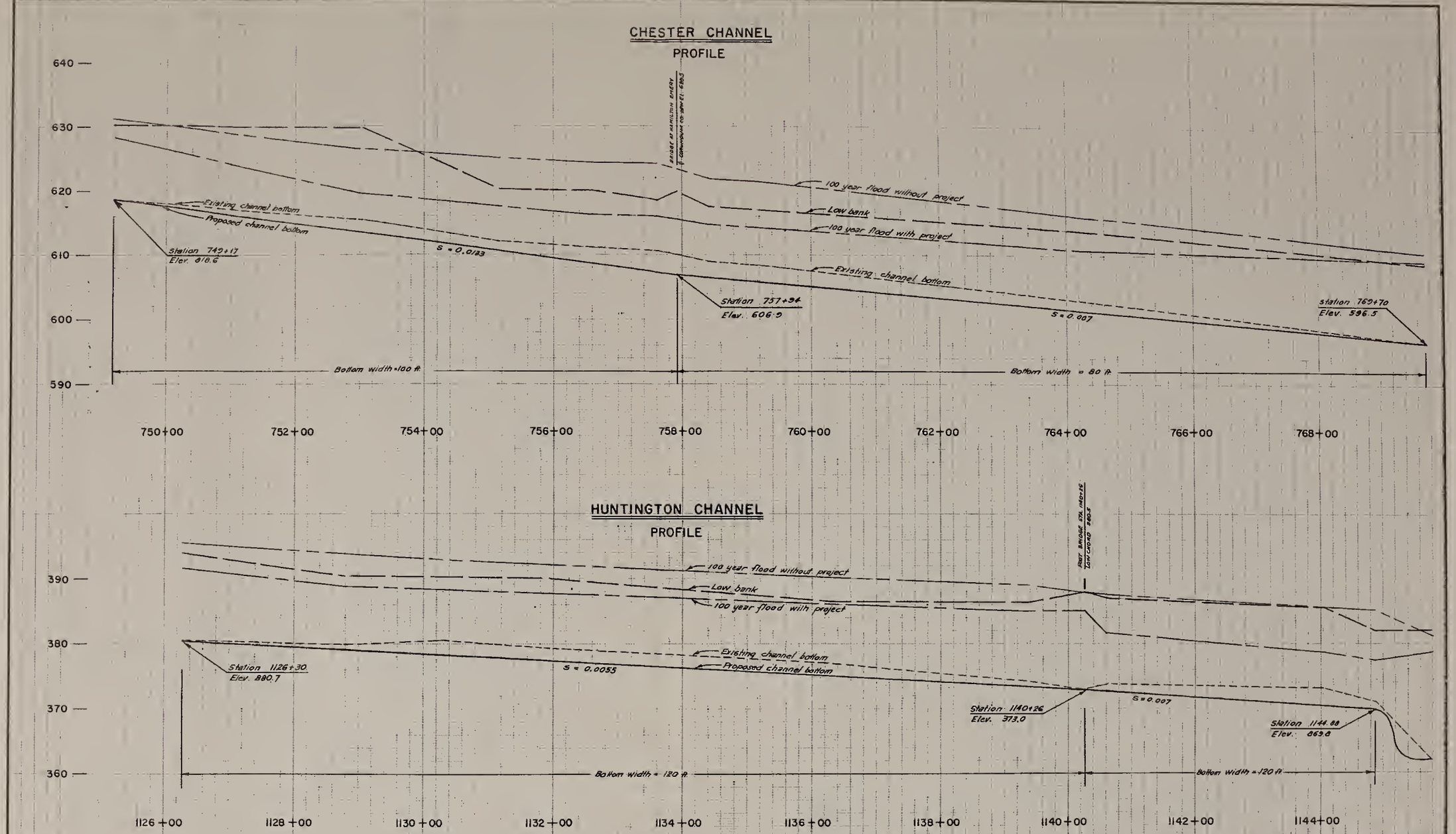


Figure 13
Preliminary Plans
CHESTER & HUNTINGTON
CHANNEL IMPROVEMENTS
WEST BRANCH OF THE WESTFIELD
RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed		Date	Approved by
Drawn	G. SMEAD	4-69	Title
Traced			Title
Checked			Sheet No. of / Drawing No.

FORM SCS 316 (APRIL 1963)

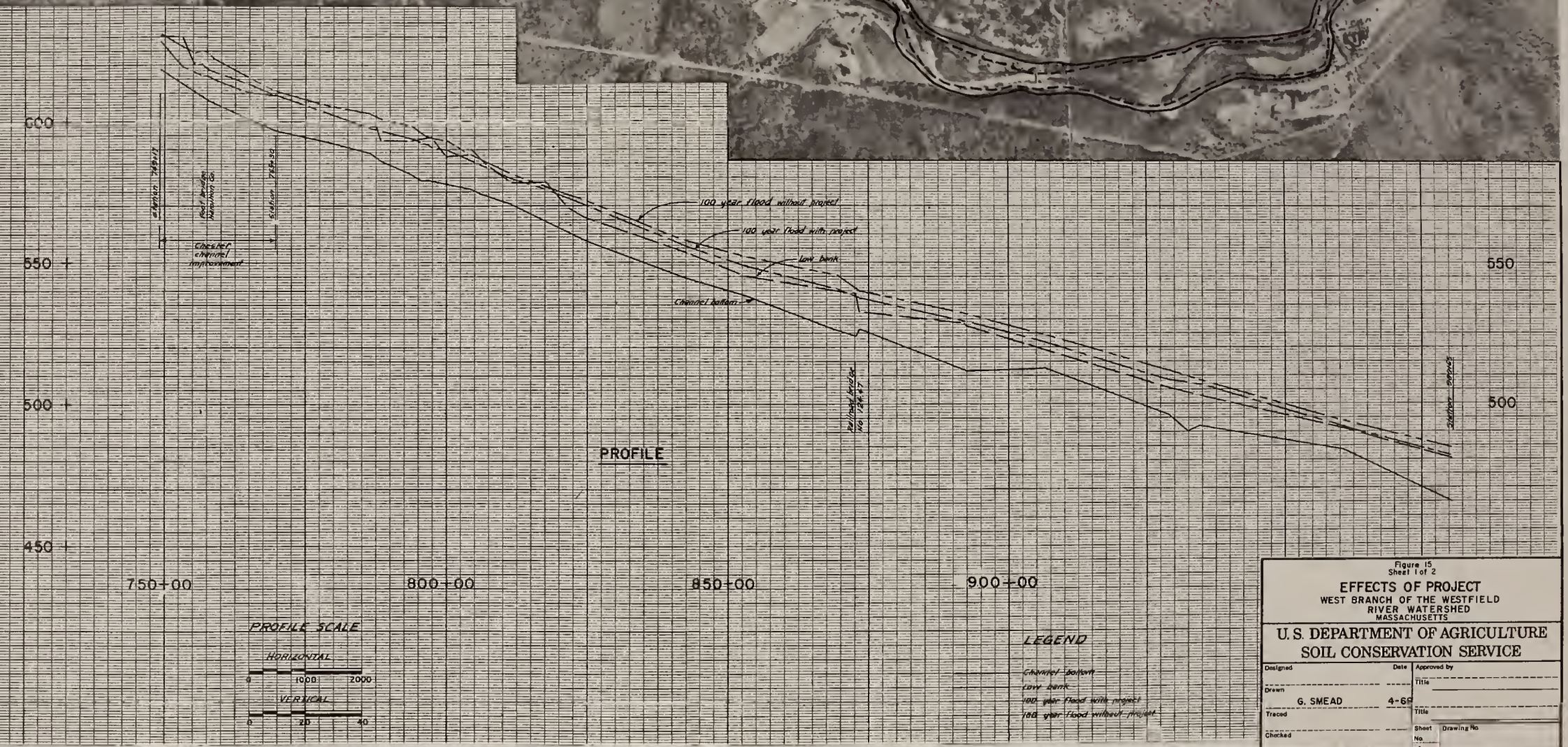


Figure 15
Sheet 1 of 2

EFFECTS OF PROJECT
WEST BRANCH OF THE WESTFIELD
RIVER WATERSHED
MASSACHUSETTS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
Drawn G. SMEAD	4-60	Title
Traced		Title
Checked		Sheet No. of / Drawing No.

Form SCS-316 (November 1955)

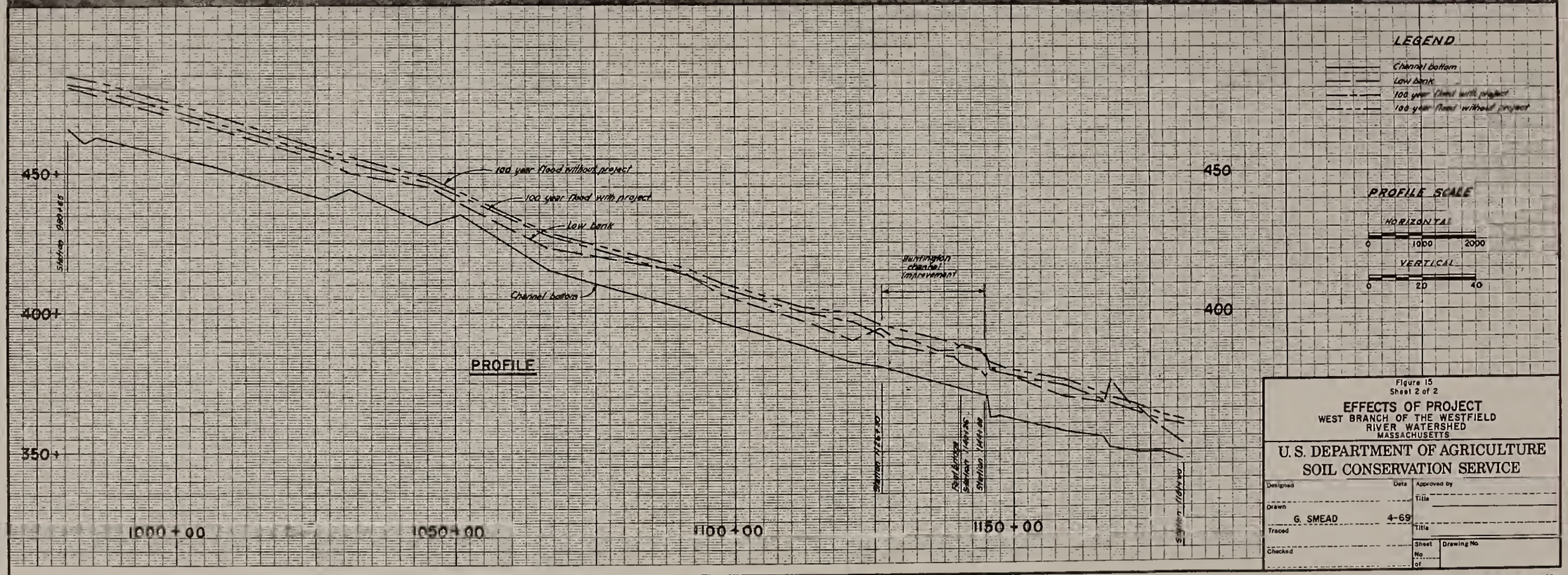


Figure 15
Sheet 2 of 2

EFFECTS OF PROJECT
WEST BRANCH OF THE WESTFIELD RIVER WATERSHED
MASSACHUSETTS

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
Drawn G. SMEAD	4-69	Title
Traced		Title
Checked		Sheet No. of / Drawing No.

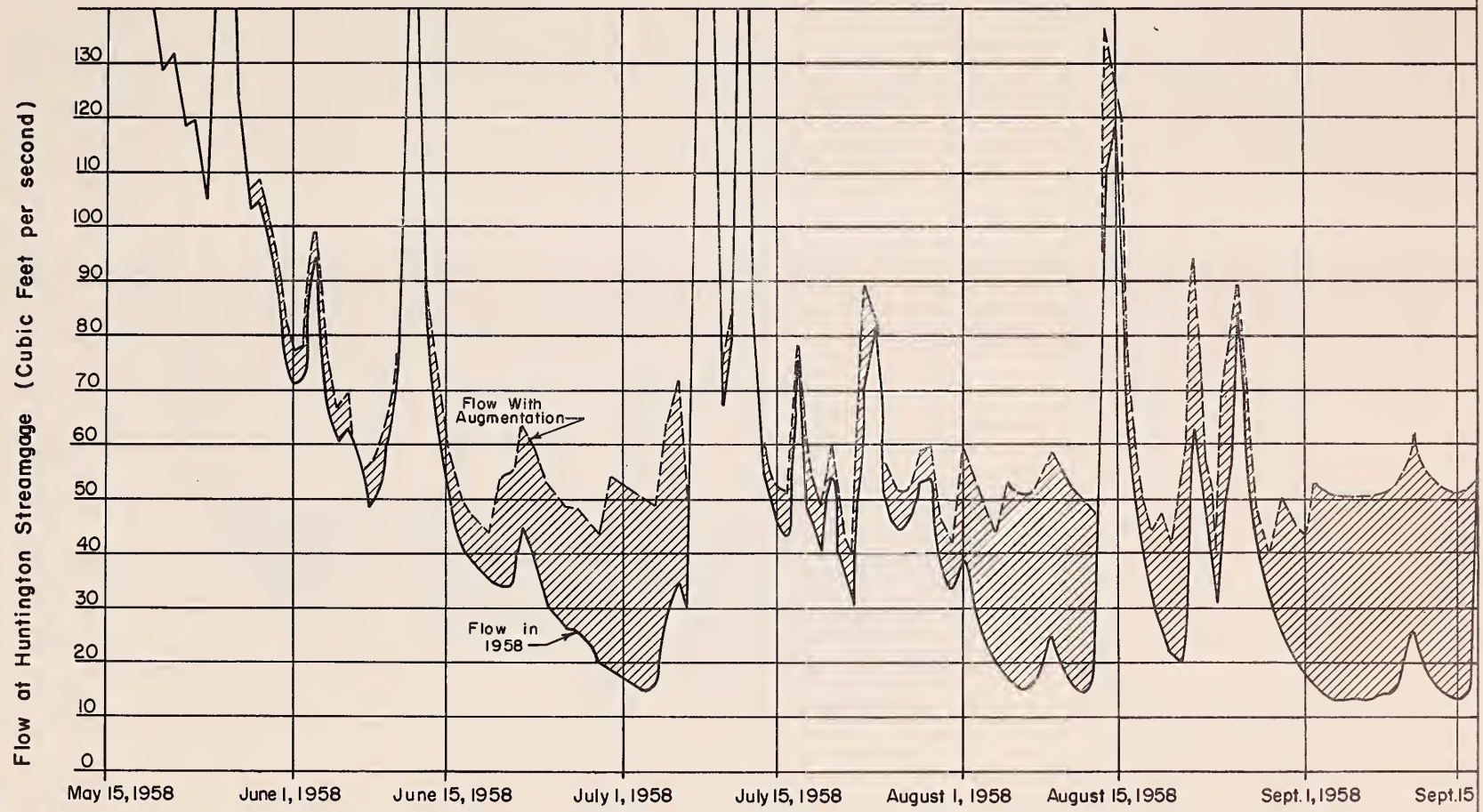
Form SCS-316 (November 1955)

West Branch of the Westfield River Watershed
Massachusetts

EFFECTS OF LOW-FLOW AUGMENTATION

At the Huntington Streamgage

For the Average Year-1958



Des. By: L.L. 3/69
Ckd By: H.R. 3/69
Dwn By: F.W. 5/69

FIGURE 16

West Branch of the Westfield River Watershed
Massachusetts

EFFECTS OF LOW-FLOW AUGMENTATION

At the Huntington Streamgage

For the Driest Year of Record – 1964

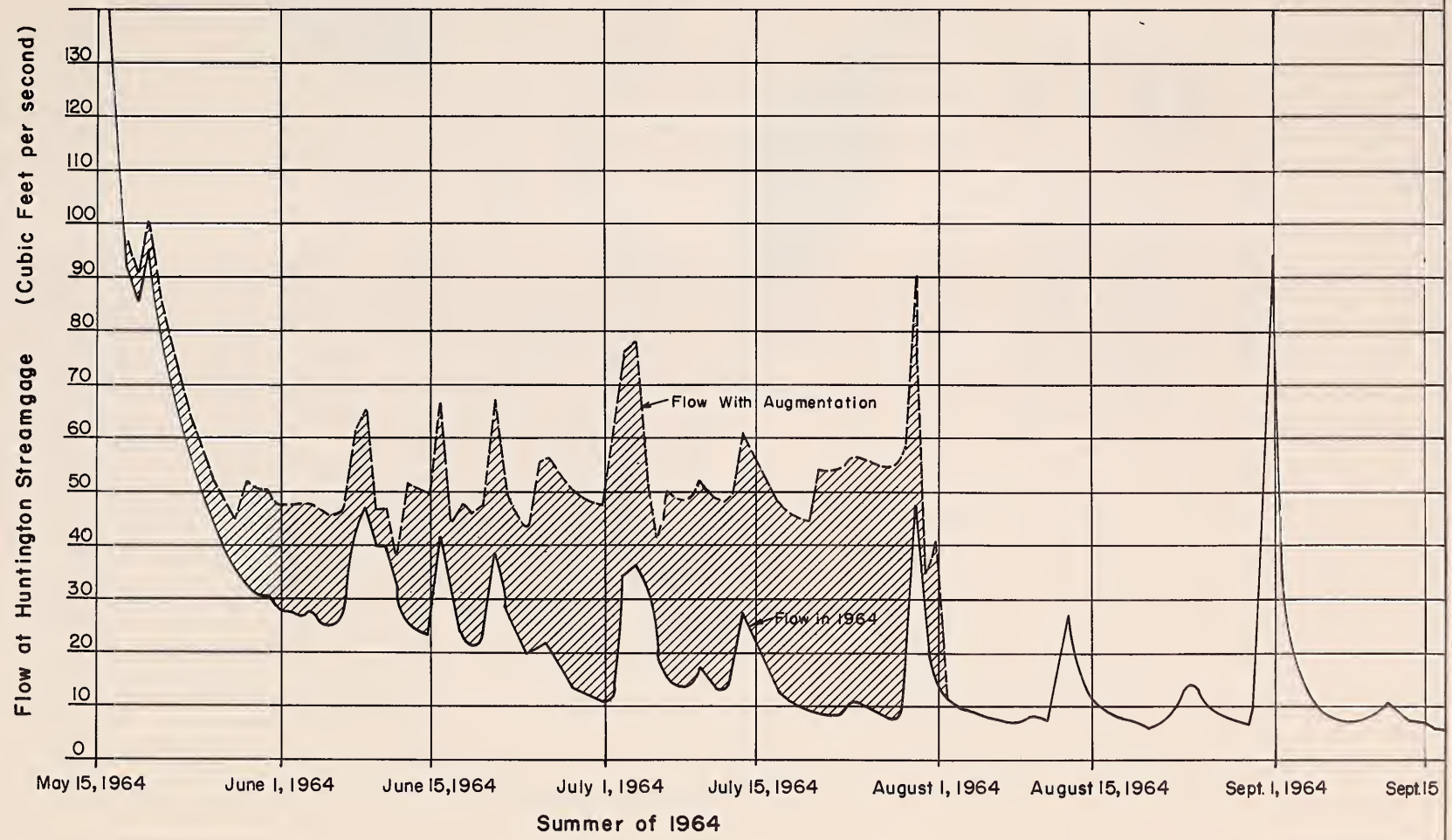
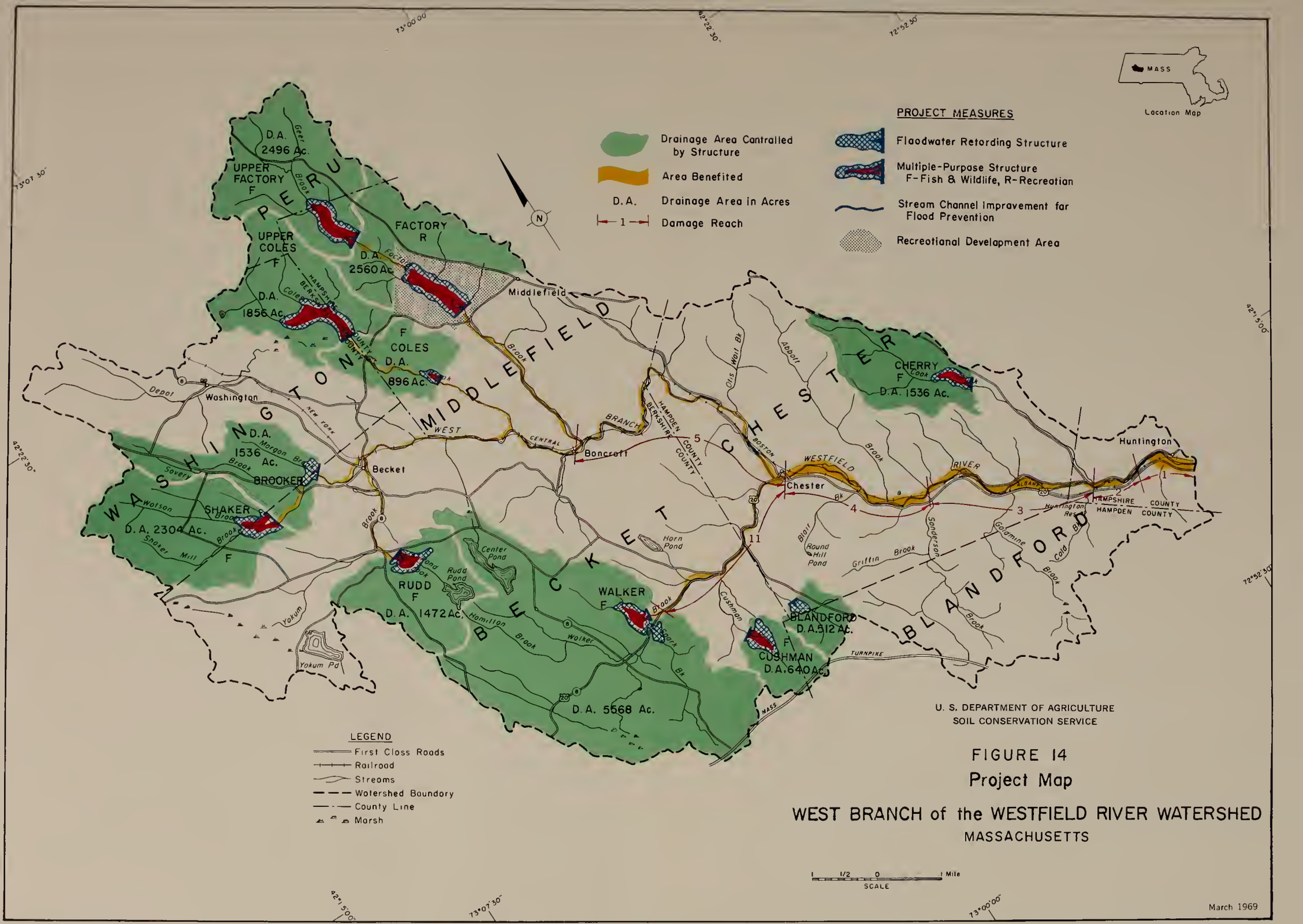


FIGURE 17



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FIGURE 14
Project Map

WEST BRANCH of the WESTFIELD RIVER WATERSHED
MASSACHUSETTS

March 1969

USDA-SCS-HYATTSVILLE, MD. 1969

NOTES

NOTES